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In Memoriam

J. W. Vickrey
1892-1959

J. W. Vickrey, California's State Highway Engineer, died on December 4 following a short illness.

Vickrey was appointed on October 1 to succeed G. T. McCoy as the chief of the State Division of Highways. He had been with the Division of Highways for 42 years. For the past 12 years he had been closely identified with the California freeway program as the division's chief planner.

On learning of Vickrey's death Governor Edmund G. Brown said:

"The death of State Highway Engineer J. W. Vickrey has deprived the people of California of one of its most brilliant and valuable civil servants.

"Mr. Vickrey devoted practically all of his professional career to this State. He has been more closely identified than any other person with the long-range planning of California's modern highway system, which is universally acknowledged to be the most advanced in the nation.

"Mr. Vickrey contributed to the growth and development of our State not only his engineering knowledge and ability, but also bold vision and a practical understanding of the legal and legislative aspects of the highway program.

"We had all looked forward to his guidance as we start to carry out the statewide master plan of freeways and expressways which he was a key man in shaping.

"His loss will be most keenly felt, even though he has trained some able assistants to carry on his work."



Vickrey was born in Hendricks County, Indiana, in 1892. He studied engineering at Danville, Indiana, and later at the Los Angeles Polytechnic Institute.

After some engineering work with the Southern Pacific Railroad and the Los Angeles County Surveyor's office, Vickrey went to work for the Division of Highways at Willits (Mendocino County) in 1917 as a transitman. For the next eight years he worked as a construction engineer and on survey parties in various parts of the State.

In 1925 he was appointed assistant engineer in charge of location and construction for District III, at that time with offices in Sacramento, and three years later was appointed District Maintenance Engineer.

In 1932 he was transferred to District IX at Bishop as Acting District Engineer and the following year was appointed District Engineer of District I at Eureka. He remained there until his promotion to Traffic and Safety Engineer for the Division of Highways in 1938, and has been in the Sacramento Headquarters office ever since.

In 1947, when California began its intensive highway modernization program under the Collier-Burns Act, Vickrey was appointed Assistant State Highway Engineer in charge of planning. He was promoted to Deputy State Highway Engineer in 1955, and has since been responsible for all the various engineering phases of the California highway program.

Vickrey, whose home was at 1371 46th Street in Sacramento, is survived by his wife, Katie; by two sons, John W. Vickrey, Jr., of Alamo (Contra Costa County), and William T. Vickrey of Los Angeles, and five grandchildren.

Mr. Vickrey's professional affiliations included membership in the American Society of Civil Engineers and the American Association of State Highways Officials. He was recently elected to the executive committee of the latter.

He was a member of Golden Empire Lodge, F. and A.M., of the Scottish Rite Bodies and the Ben Ali Shrine, and was a past patron of Rainbow Chapter No. 385, Order of the Eastern Star.

California Highways and Public Works

Official Journal of the Division of Highways, Department of Public Works, State of California

Vol. 39 January-February Nos. 1-2

New Signs, Rezoning For 65 M.P.H. Limit

The State Division of Highways is completing a major program of establishing and revising speed zones as a result of the new 65-mile-an-hour maximum speed limit which became effective January 1, 1960.

From a traffic engineering standpoint and safety requirements, the new speed limit involved more than the posting of "Maximum Speed Limit 65 Miles" signs. Signs were posted where appropriate, but in addition a number of speed zones had to be established. About 200 miles of highway were affected by new and revised speed zones.

FRONT COVER — On January 1, new signs, such as this one on U.S. 40 near the Nevada state line, appeared on California highways to inform motorists of the new speed limit now in effect.

—Photo by Jack Meyerpeter

New zones in a large measure were extensions of existing zones adjacent to communities in areas which are partially built up, have closely spaced intersections or a considerable amount of crosstraffic. Some highway locations where 55 miles an hour is appropriate are now signed "Speed Limit 55" whereas the old 55-mile prima facie limit made signs unnecessary.

At all highway entrances to California, large signs warn that the maximum speed limit for autos is 65 miles an hour, all trailers 45 miles an hour and trucks 45 miles an hour.

"Maximum Speed Limit 65 Miles" signs have been placed at entrance points to interstate highways and elsewhere as appropriate.

The signs advising motorists entering the State are extra large, 9 by 7 feet, and mounted 7 feet above the ground.

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Appointments

Four Engineers Named To Top Highway Posts

J. C. Womack has been named State Highway Engineer and Chief of the Division of Highways.

Womack, a 30-year employee of the division, was Deputy State Highway Engineer under J. W. Vickrey, who died on December 4.

Other appointments in the division included the promotion of J. P. Murphy to Deputy State Highway Engineer (Planning), succeeding Womack; the promotion of Lyman R. Gillis to Assistant State Highway Engineer (Administration), succeeding Murphy; and the promotion of George A. Hill to District Engineer (Planning) for District VII in Los Angeles, succeeding Gillis.

Regarding Womack's promotion to State Highway Engineer, Director of Public Works Robert B. Bradford,



J. C. Womack



J. P. Murphy

who announced the appointment, said: "With California on the threshold of a long-range freeway development program, the people of this State are fortunate in having a highway planner of proved ability in charge of our state highway work. Mr. Womack has been closely associated with Mr. G. T. McCoy, who retired recently as State Highway Engineer, and particularly with Mr. Vickrey, whose premature death shocked us all. He can be counted on to continue their tradition of efficiency and sound planning."

Womack's advancement to the post of State Highway Engineer climaxes a highway engineering career which began in Oregon and Washington in 1922 on location and construction work for the U. S. Bureau of Public Roads. A native of Emmett, Idaho, he was educated in Seattle and attended the University of Washington. He served as a second lieutenant of field artillery in World War I.

Joining the Division of Highways in 1929, he first served as District Location Engineer and as a resident engineer on construction projects in District III (Sacramento-Marysville). From 1935 to 1942 he supervised location surveys and planning development for the district, and was promoted to District Maintenance Engineer in 1942. In succeeding years he served as Engineer of Surveys and Plans and as District Construction Engineer.

He was promoted to Assistant District Engineer in District III in 1948, but later the same year he moved to Headquarters Office in Sacramento for the Division. He held this post for the next seven years, with responsibility for processing all highway improvement projects through Headquarters Office from their inception to the detailed design stage, including route adoption, freeway agreements, planning programs and budgets.

In 1955 Womack was promoted to Assistant State Highway Engineer—Planning, with supervision over six staff departments. In October 1959, he was advanced to Deputy State Highway Engineer—Engineering, succeeding Mr. Vickrey in that post upon



L. R. Gillis

the latter's appointment as State Highway Engineer.

Womack is a member of the American Society of Civil Engineers, the American Association of State Highway Officials (currently chairman of the A. A. S. H. O. Committee on De-

. . . Continued on page 67

Freeways in District VII

By E. T. TELFORD
Assistant State Highway Engineer

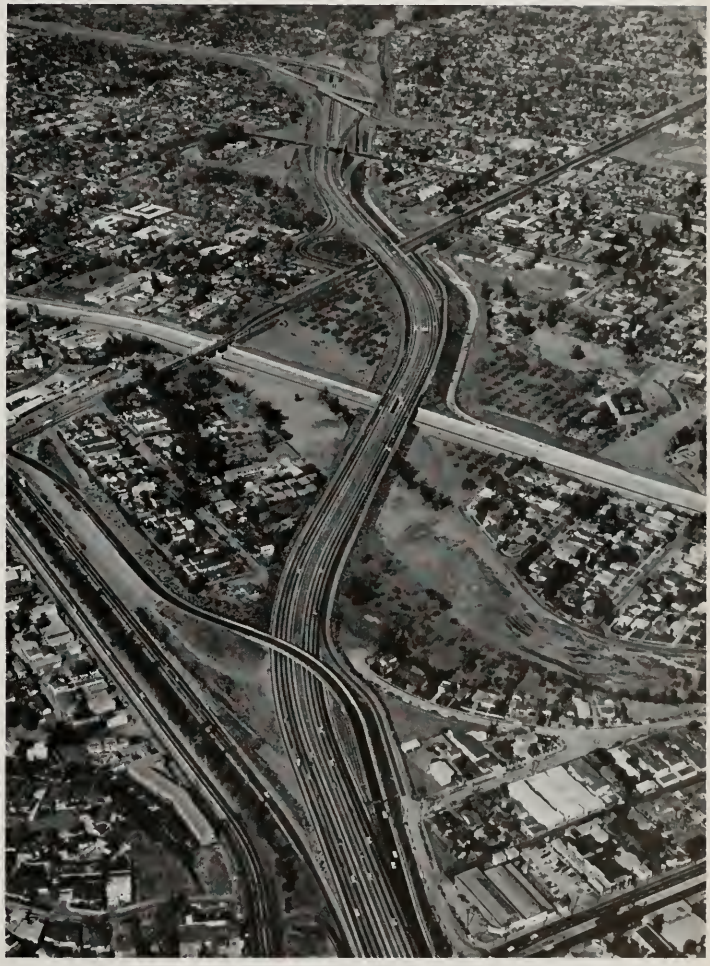
Within the three counties of Los Angeles, Orange and Ventura (including 92 incorporated cities) which comprise District VII, are about 6,800,000 people operating nearly 3,500,000 motor vehicles. By 1980 this number of people and of motor vehicles probably will have doubled. To serve these people the Legislature has provided in Senate Bill No. 480 about 1,500 miles of the California freeway system in District VII. About 700 miles of the routes in the system within this district have been adopted by the California Highway Commission.


E. T. TELFORD

As of June 30, 1959, we had obligated a total of slightly over $800 million in freeways since the start of the freeway program. This has given District VII 181 miles of freeways and 103 miles of expressways, with 43 miles of freeways under construction at a construction cost of $84 million. We also have right-of-way acquired equal to somewhat more than two years' requirements beyond current construction. Completion of the system will require about $4 billion after the 1959-60 fiscal year.

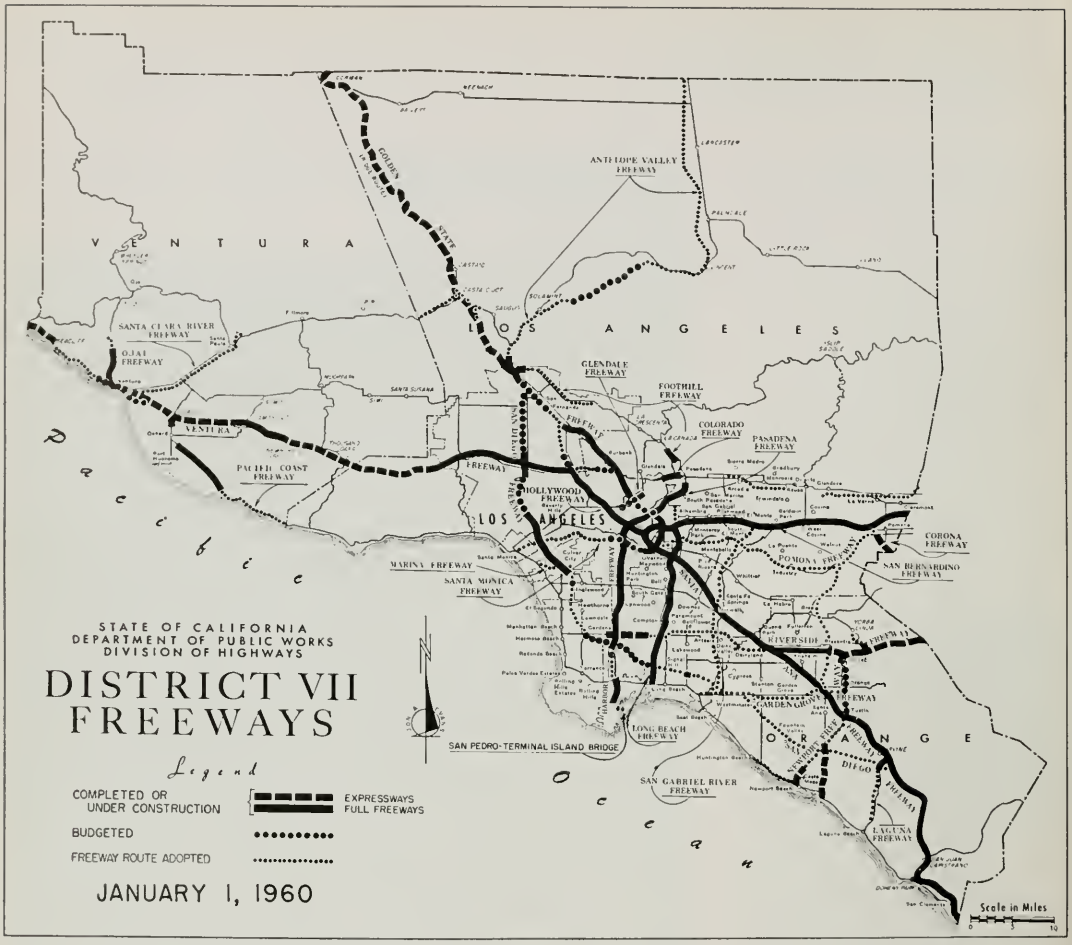
During the fiscal year July 1, 1958, to June 30, 1959 we opened to traffic 31.9 miles of freeways—16 miles in Los Angeles County, 10.2 miles in Orange, and 5.7 miles in Ventura. Since July 1 some additional mileage has been opened and more will be opened in the next few months. Some of the important sections soon to be opened are:

Ventura Freeway—Two sections, totaling 8.1 miles—to be opened April 1960. This will complete the Ventura Freeway from Hollywood Freeway to west city limits of Los Angeles.


Looking northward along the Hollywood Freeway extension from Lankershim Boulevard (foreground). The Venturo Freeway interchange is in the background.

Harbor Freeway—190th Street to 124th Street, 4.5 miles—to be opened August 1960.

San Diego Freeway—In San Clemente, Orange County, 7.8 miles—to be opened December 1960. In West Los Angeles, Jef-



ferson to Venice, 2.3 miles—to be opened June 1960.

Golden State Freeway—In East Los Angeles, 4.3 miles, Sixth Street to Pasadena Avenue—to be opened February 1960.

This section connects to the East Los Angeles Interchange now under construction, to the San Bernardino Freeway, and on the north to a section of the Golden State Freeway budgeted but not as yet under construction.

In view of the difficulties we have had in the financial field, due to drastic cutback of federal aid on interstate system highways, it will be simpler to combine the budget figures for the two fiscal years 1959-60 and 1960-61 as they now stand.

Right-of-way	$128,016,500
Construction	207,723,000
Two-year total	$335,739,500
Freeway construction only	$192,475,000

If we add to freeway construction the probable right-of-way acquisition for freeways, we have a figure of about $300,000,000 representing planned two-year investment in freeways. The two-year goal anticipates 68 new miles of freeway and 17 miles widened (six to eight, and four to six lanes). Most of this widening is scheduled on the San Bernardino Freeway. In addition there is provided a total of 16 miles of grading to be followed by later contracts for completion. For the 1959-60 fiscal year, we have under contract 13.8 miles of freeway representing a construction cost of $26 million.

Some specific items of major interest in the two fiscal years are:

San Diego Freeway—in Los Angeles County—Construction, 16 miles (in addition, Burbank Blvd. to Golden State Freeway, 8.5 miles—grading only)	$45,392,000
Golden State Freeway—Construction, 11.5 miles	44,375,000
Santa Monica Freeway—Construction, 5.6 miles	47,700,000
San Bernardino Freeway—Added lanes, 17 miles	5,750,000

Antelope Valley Freeway—Grading and structures, 7.6 miles	8,000,000
San Diego Freeway—in Orange County, 7.8 miles	6,500,000
Newport Freeway—in Orange County, 8.4 miles	8,800,000
U.S. Route 101 Freeway—City of Ventura, 7.5 miles	15,825,000

For planting of freeway roadsides for erosion control and landscaping, we have available $3,500,000 in the two fiscal years.

By the end of 1960 we will have in operation 90 miles of freeway on US 101 between the San Diego-Orange county line and the west city limits of Los Angeles. The rate at which projects can go to contract is controlled by the anticipated rate of cash flow from all sources of revenue including reimbursement from the federal government. We hope that in the future this flow will follow a consistent pattern and thus permit efficient planning and predictable accomplishment.

Common to all freeways is the problem of the proper treatment that should be given to central dividing or median strips to the end that cross-median accidents may be reduced both in number and severity.

Median Barriers

Exhaustive scientific studies and tests by Headquarters Materials and Research Laboratory in Sacramento relative to the problem of cross-median accidents on freeways and effectiveness of median barriers during the last three years led to important developments during 1959. It was found that there were two types of barriers that were the best and most effective of the 15 types that were tested. These are the combination cable-chain link barrier, and the blocked out metal beam barrier. The first installation was on the Ventura Freeway, west of the San Diego Freeway, made as a part of a $192,500 landscaping contract to Valley Crest Landscape Nurseries, Inc. This contractor placed 12,500 lineal feet of the combination cable-chain link barrier in the 22-foot median area. A second median barrier contract—suspended in September 1959 because of the steel strike—was awarded to Milleman and Sooy for $343,900 and provides for construction of 17,000 lineal feet of cable-chain link barrier and 30,000 lineal feet of blocked out beam barrier on the Hollywood and Santa Ana Freeways at various locations between Benton Way and Lakewood Boulevard, a distance of 14.1 miles. The 1960-61 budget also has a $300,000 allocation for median barrier construction on portions of the Harbor Freeway and Pasadena Freeways. (See articles Median Study, by George M. Webb, Traffic Engineer, and "Impact Tests," by John L. Beaton and Robert N. Field, Jr., in *California Highways and Public Works*, July-August 1959.)

There are in District VII 30 freeways totaling about 700 miles upon which the California Highway Commission has taken official action in adopting as freeway routes. Below, in alphabetical order, there is reported basic information concerning these freeways.



A new type median barrier fence was recently installed along the Ventura Freeway. This view eastward is taken from Louise Avenue. The home of Edward Everett Horton, motion picture and television star, can be seen in the background.

FREEWAY AND EXPRESSWAY SYSTEM IN DISTRICT VII



LOS ANGELES – ORANGE AREA

Antelope Valley Freeway

The 54 miles of freeway location in Los Angeles County on US Highway 6 from the Golden State Freeway north of San Fernando to the Kern county line were adopted by the California Highway Commission in three separate units during 1955, 1956 and 1957. The preliminary estimate of right-of-way acquisition and construction for this freeway is $60,000,000.

The first construction, expected to start late in 1960, is for grading and drainage structures on approximately eight miles between the community of Lang and Escondido Canyon Road. Financing of this construction, which does not provide for the paving that will have to come later, is from the item of $8,000,000 in the 1960-1961 Budget as adopted by the California Highway Commission in October 1959. Satisfactory progress has been made in right-of-way acquisition so that this construction can go forward without delay. Under future budget allocations this initial grading and construction of drainage structures can be extended and pavement provided so that a usable section 16 miles long between the community of Solamint and the Red Rover Mine Road can be completed and opened to traffic. Engineering studies and preparation of contract plans are in progress over the entire 54 miles of the Antelope Valley Freeway.

Artesia Freeway

As a result of a public hearing held in Los Angeles on November 12, 1958, for the portion of the Artesia Freeway between Alameda Street and Palo Verde Avenue traversing portions of the Cities of Compton, Long Beach, Bellflower and Dairy Valley, the California Highway Commission adopted this unit as a freeway on February 18, 1959.

Preliminary engineering studies are now in progress and negotiations have been started, with the various cities involved, looking toward the execution of freeway agreements.

Five miles of the Artesia Freeway near the westerly end from Normandie Avenue to 0.2 mile east of Alameda Street, were completed to expressway and divided highway standards during previous years.

Designing and preparation of contract plans are now under way to convert this section to full freeway standards. Design is also in progress for the section from the San Gabriel River to the Santa Ana Freeway. A right-of-way acquisition program is currently under way.

Colorado Freeway

Development of State Sign Route 134 as the Colorado Freeway will eventually extend from the Golden State Freeway on the west to the junction with the Foothill Freeway in Pasadena on the east. At present, only 2.3 miles of this route has been constructed as a full freeway. This completed portion extends from Eagle Vista Drive in Eagle Rock to Holly Street in Pasadena. This freeway, including the large arch bridge structure over the Arroyo Seco which was completed June 18, 1954, and dedicated as "Pasadena Pioneers Bridge," cost a total of $8,669,000.

Preliminary engineering studies have been carried out on several possible locations for extending this freeway westerly from Eagle Rock to the Golden State Freeway, and on October 8, 1959, a public meeting was held in the Glendale High School relative to the various alternate routings that were under study. There was a great deal of public interest in this meeting and the attendance exceeded 2,500 persons. Information which was presented at the meeting, together with subsequent information received, is being reviewed so that a report with recommendations may be made by the State

Highway Engineer to the California Highway Commission.

Two public hearings relative to the location studies for the portion of this freeway within Pasadena have previously been held (in conjunction with discussions of the Foothill Freeway).

From the latest 1959 traffic counts, the average daily traffic on the Colorado Freeway near Linda Vista Avenue is 23,000 vehicles.

Corona Freeway

This freeway, formerly known as the Temescal Freeway, for 3.2 miles between Fifth Street in Pomona and a point one mile south of Riverside Drive in San Bernardino County, was completed to four-lane expressway standards in June 1958 at a cost of $800,000.

Plan work has been completed to convert this expressway to full freeway standards for its entire length of 4.4 miles from the San Bernardino Freeway to the San Bernardino county line. The estimated cost of this reconstruction is $2,500,000. It will require grade separation bridges and interchange facilities at Holt Avenue, Valley Boulevard and Fifth Avenue. Widening of the existing bridges over the Southern Pacific Railroad and Union Pacific Railroad will also be carried out. The start of reconstruction to obtain a full freeway depends upon future financing.

Corona Del Mar Freeway

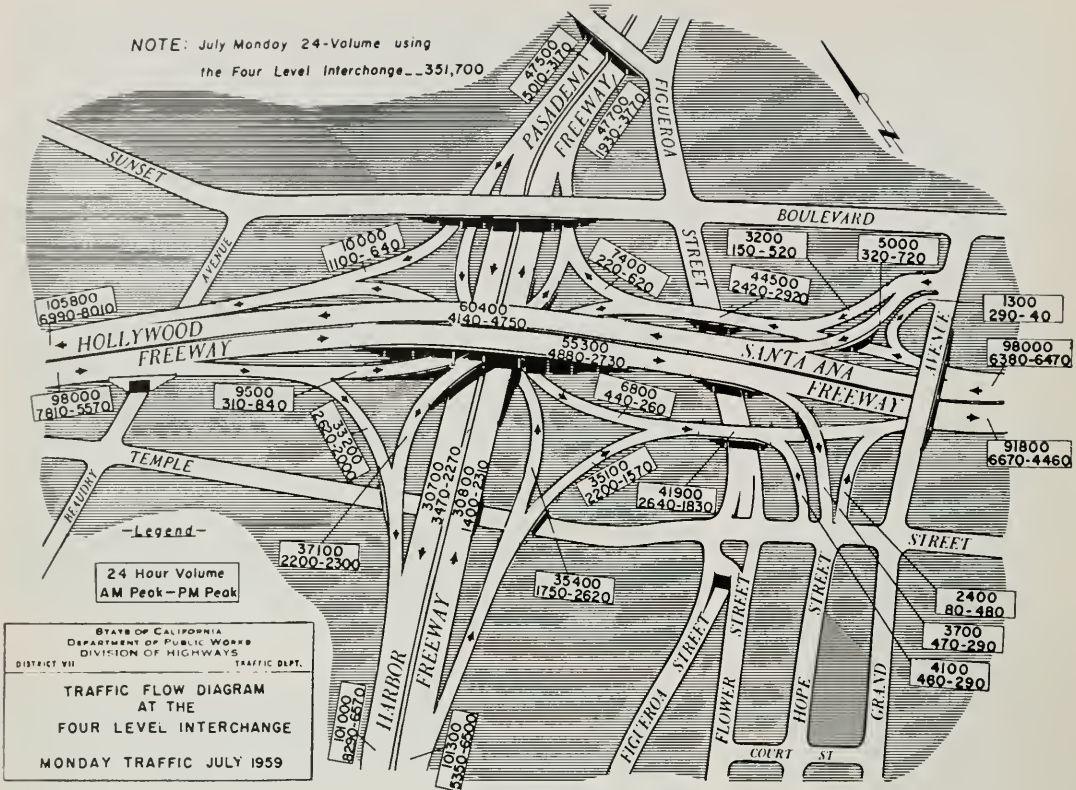
State Highway Route 184 in Orange County from Coast Highway, US 101 Alternate, to Newport Freeway, State Highway Route 43, was adopted by the California Highway Commission as a freeway January 26, 1940. Of the total length of 6.3 miles, 2.3 miles at the southerly end adjoining US 101 Alternate were completed in 1942 as a four-lane divided highway. During the same year and under the same contract four miles were completed as a two-lane highway. This construction contract was carried out by Mittry Brothers at a total cost of $215,000. Further construction on this freeway route is not proposed in the immediate future. Some reconstruction will be necessary in connection with the future development of the San Diego Freeway in this vicinity.



Construction on the Long Beach Freeway extension. This northward view was taken from above Olympic Boulevard.



Another view of construction on the Long Beach Freeway extension showing the interchange with the Santa Ana Freeway in the foreground.



Base map courtesy of Auto Club of So. California

Foothill Freeway

The Foothill Freeway, the major portion being State Highway Route 9, is on the U.S. Interstate system. It extends from junction with the Golden State Freeway north of San Fernando southeasterly and easterly to the San Bernardino county line near Claremont. The California Highway Commission has adopted four freeway location units on the Foothill Freeway. These are as follows:

From Filbert Street to Foothill Place—9.7 miles, adopted March 26, 1958.

From Grand Avenue to San Bernardino county line—6.8 miles, adopted April 29, 1959.

From Michillinda Street to Bradbourne Avenue—5.9 miles, adopted May 20, 1959.

From Glendora Avenue to Grand Avenue—4.7 miles, adopted November 18, 1959.

To date the only construction on this freeway is a section 1.8 miles long in the Altadena-Flintridge area from Hampton Road to Montana Street. The cost of this construction, which was completed October 28, 1955, was $2,098,000.

Covering the section of the Foothill Freeway from Bradbourne Avenue at the west city limits of Irwindale through Azusa to Glendora Avenue, the California Highway Commission on November 20, 1959, held a public hearing in Los Angeles. At the time of this writing, the California Highway Commission had not taken official action in adopting the location for this section.

Remaining sections of the proposed Foothill Freeway through Pasadena, Altadena, La Canada and La Crescenta are under preliminary engineering study. Two public meetings relative to freeway location studies in Pasadena have previously been held.

Garden Grove Freeway

This freeway extends for 17.9 miles from US 101 Alternate to the Newport Freeway near the City of Orange. Resolutions of the California Highway Commission between 1954 and 1957 adopted this route as a freeway, and the commission on October 22, 1957, officially named it the Garden Grove Freeway. Contractors Cox Brothers Construction Company and J. E. Haddock, Ltd. on July 15, 1959, completed reconstruction of 5.4 miles of this route between Los Cerritos Channel and Knott Avenue. The cost of this work was $1,473,000.

This job has been designated as an "interim project," providing a four-

lane divided highway now, until full freeway construction can go forward at a later date. An unusual feature of this contract was that 2.1 miles of this construction along the Los Alamitos Naval Ordnance Area will at some future time become a part of the San Diego Freeway as well as the Garden Grove Freeway.

Design work is under way on the Garden Grove Freeway from Bolsa Chica Road easterly to the Newport Freeway.

Glendale Freeway

A total of 3.2 miles of the Glendale Freeway has been adopted by the California Highway Commission, of which 1.1 miles between the Los Angeles River and Avenue 36 near Eagle Rock Boulevard was completed November 3, 1958, to full freeway standards at a cost of $2,832,000.

Just southerly of the completed section, in connection with construction on the Golden State Freeway between Arnold Avenue and Glendale Boulevard, the interchange between these two freeways will be constructed as well as a new bridge across the Los Angeles River. This will be financed from the item of $14,845,000 in the 1959-1960 Budget. It is anticipated that this section will be ready to advertise early in 1960.

In the 1960-61 fiscal budget, there is an item of $2,700,000 for extending the Glendale Freeway from the Golden State Freeway southerly to a connection with Glendale Boulevard. It is anticipated that this construction will be ready to advertise for contract in mid-1960.

Under preliminary engineering study is the section westerly of Glendale Boulevard to junction with the Hollywood Freeway and the section northerly from Avenue 36 to junction with the Foothill Freeway.

Golden State Freeway

One of the most important routes in District VII in point of traffic service and relief to existing overly taxed major arterials such as the Hollywood Freeway—which has an average daily count of 194,000 motor vehicles westerly of the 4-level structure—will be the Golden State Freeway, completing an "East Loop" bypass around the Los Angeles Civic Center to a junction with the San Diego Freeway north of the City of San Fernando.

When completed it will effectively skirt present traffic concentrations in the "slot" or hub area of Los Angeles and provide a more direct alternate route with low-percentage grades for truck traffic plying between the north valley and greater Los Angeles markets and industry to the south. (For a complete discussion of the Golden State Freeway see article "Freeway Loop," by Lyman R. Gillis, District Engineer, *California Highways and Public Works*, September-October 1959.)

Construction is in progress on four separate jobs along the route of the Golden State Freeway north: Sixth Street to Mission Road, 3.1 miles, under $7,626,500 contract to Vinnell Company, Inc. and Vinnell Construc-



An aerial view northward showing construction work on the interchange which will connect the existing San Bernardino Freeway and the Long Beach Freeway extension. Los Angeles State College is in the background.



A view of the completed Lincoln Avenue widening project in Anaheim.



A view eastward along Garden Grove Boulevard in Garden Grove.

tors, with an estimated completion date of February 1960; Mission Road to Pasadena Avenue, 1.2 miles, under $3,040,500 contract to Boesplug & McLaughlin, with an estimated completion date of February 1960; Burbank Boulevard to Roscoe Boulevard, 4.1 miles, under $8,324,000 contract to Ukropina-Polich and Kral, with an estimated completion date of May 1961; and Roscoe Boulevard to Lankershim Boulevard, two miles, under $3,478,200 contract to B. J. Ukropina, T. P. Polich, Stevel Kral and John R. Ukropina, with an estimated completion date of May 1961.

The Golden State Freeway in the Los Angeles-Burbank area is completed from Glendale Boulevard north for 7.6 miles to Burbank Boulevard. The most recent construction, extending the freeway 1.6 miles between Alameda and Burbank Boulevards at a cost of $4,240,000 (State's share), was completed on August 5, 1959.

The 1959-60 Budget made provision for continued construction on the Golden State Freeway and the Pasadena and Glendale Freeway interchanges in the sum of $19,500,000. Work on this double project, which would extend the Golden State Freeway from Pasadena Avenue north to Glendale Boulevard, was deferred because of lack of federal funds and will be advertised for construction early in 1960. The 1960-61 Budget includes $14,000,000 for the Golden State Freeway—6.4 miles from Osborne Street north to San Fernando Road near the Foothill Boulevard interchange (also some construction on the San Diego Freeway).

Thus, the Golden State Freeway from the East Los Angeles Interchange just north of Olympic Boulevard to junction with the San Diego Freeway near the City of San Fernando is for the most part either completed, under construction or financed for construction. The sole exception is a short link of 2.4 miles between Lankershim Boulevard and Osborne Street, which awaits future financing. There is reasonable expectation now that this will all be completed and opened to traffic within the next three years.

Harbor Freeway

The Harbor Freeway, with termini 22.2 miles apart, extending between the four-level structure in the Los Angeles Civic Center and Battery Street in San Pedro, is completed for 10.6 miles as far south as 124th Street and for 2.5 miles from Pacific Coast Highway to Battery Street.

On September 26, 1958 another contract in excess of $8,000,000 was started on the Harbor Freeway. This project, when completed sometime in August 1960 will extend the Harbor Freeway 4.7 miles southerly from 124th Street to a connection with Figueroa Street approximately half a mile south of 190th Street.

The work includes constructing an eight-lane freeway, 17 bridges, pumping plant and 10 retaining walls. The bridge structures cover the field rather well, inasmuch as they include steel girder, prestressed girder and box girder construction. On- and off-ramp facilities are being constructed at El Segundo Boulevard, Rosecrans Avenue, Alondra Boulevard and 190th Street with a full interchange constructed at State Sign Route 14 (Artesia Boulevard).

The two most interesting features of construction were that of the Dominguez Channel Bridge structure and that of excavating some 140,000 cubic yards of "hot" rubbish from old dumps on either side of the Dominguez Channel. The work of excavating and disposing of trash was further complicated by the fact that the bottom portion of this material was below sea level as well as below the water elevation in the channel. The trash material consisted of nearly all combustibles in varying stages of decomposition. The material, upon being exposed to the air would flame up and smoulder with a very disagreeable odor. The contractors, J. E. Haddock, Ltd., and Ukropina, Polich and Kral, excavated this material by various types of operations, i.e., dozers and self-propelled scrapers, rear-dump two-wheeled trailers, etc. The bottom portion, a wet material, was excavated by a 1½-cubic-yard dragline into rear-dump two-wheeled trailers.

The Dominguez Channel Bridge is a three span, prestressed, concrete girder bridge, some 311 feet in length. Earth dikes were constructed across the channel above and below the structure and the resulting area was pumped dry. The footing piles, footings and columns were then erected. The 56 concrete girders were cast on the adjacent freeway grade, using steel forms, and post-tensioned. These girders were erected using, among other various sizes of cranes, a new 80-ton truck crane, which is believed to be the largest in this area.

The only other major construction on the Harbor Freeway during 1959 was incidental to the future Santa Monica-Harbor Freeway interchange at Venice Boulevard, where bridge structures were built across the Harbor Freeway. In order to carry out the work, a full eight-lane asphalt-paved detour was looped around the construction site to provide uninterrupted flow of Harbor Freeway traffic (an estimated 190,000 vehicles per day). The exceedingly complicated timing of traffic shifts from the old roadway to the new and back again, the engineering of the transition moves, and the general co-ordination of the operation was a singular achievement on the part of contractor's crews and state engineers. This spectacular detour, in service for 14 months (until October 4, 1959) and handling approximately 70,000,000 cars and trucks in the interim, was built at a cost of $380,000. After completion of the Santa Monica Freeway structure, the detour was razed and the salvage materials utilized for other construction. (See article "First Contract" by Lloyd A. Compton, Resident Engineer, Bridge Department, *California Highways and Public Works*, July-August 1959.)

The interchange facility between the Harbor Freeway and the San Diego Freeway will be built as a part of the construction on the San Diego Freeway between Carson Street and 190th Street which is financed in the 1959-1960 fiscal year budget. There will then remain four miles between the San Diego Freeway interchange and Pacific Coast Highway, estimated to cost $7,000,000, that will require future financing to complete the Harbor Freeway for its entire length of 22.2 miles.

From the latest 1959 traffic counts, the average daily traffic on the Harbor Freeway immediately south of the four-lane grade separation is 195,000 vehicles.

Hollywood Freeway

The Hollywood Freeway and the Hollywood Freeway Extension together total 16.8 miles in length, extending from Spring Street in the Los Angeles Civic Center via Cahuenga Pass in Hollywood to junction with the Golden State Freeway near Wentworth Street in the San Fernando Valley.

At present the Hollywood Freeway is completed to Moorpark Street in North Hollywood, where it interchanges with the Ventura Freeway. A $3,000,000 item in the 1960-61 Budget will extend it 0.7 mile north to Magnolia Boulevard and will include the following structures: Tujunga Avenue undercrossing, Magnolia Boulevard undercrossing, Morrision Street pedestrian undercrossing, and Otsego Street pedestrian undercrossing.

North of Magnolia Street the Hollywood Freeway Extension is under design, and right-of-way is being acquired for future construction.

Imperial Freeway

In Orange County the Route 176 freeway is referred to locally as the "Imperial Freeway," taking its name from the fact that the northerly end ties into Imperial Highway. The freeway route adoption by the California Highway Commission on January 15, 1952, included 3.1 miles extending from Yorba Linda Boulevard to the Riverside Freeway. A two-lane bridge on this freeway route has been completed over the Santa Ana River, which, with approaches, cost approximately $280,000. This two-lane bridge, which is now operating carrying two-way traffic, will become a one-way bridge when the second structure is built alongside to convert this route to a full freeway. Design work on this freeway is now in progress.

Laguna Freeway

This is the official name given State Sign Route 185 between the City of Laguna Beach and the Santa Ana Freeway. It is 8.4 miles long. Two miles of the freeway were recently completed to expressway standards at a cost of approximately $500,000. This construction covered two lanes of the ultimate four-lane freeway. The work was carried out in conjunction with Santa Ana Freeway construction.

Preliminary design plans are now in progress for the remaining 6.4 miles of this freeway in order that, when funds become available, freeway construction can be carried out to connect with the completed expressway on this route within the City of Laguna Beach at the southerly end of this freeway.

Long Beach Freeway

South of the Santa Ana Freeway the 16.8 miles of the Long Beach Freeway to Pacific Coast Highway in Long Beach were completed in 1958, and details of construction costing $50,000,000 including right-of-way were described in the September-October 1958 issue of *California Highways and Public Works*.

A minor improvement of considerable importance was completed July 30, 1959, which provided a new off-ramp for northbound traffic from the Long Beach Freeway to Long Beach Boulevard in the City of Long Beach at a cost of $40,000. Mention should also be made of the fact that southerly of the official south end of the Long Beach Freeway at Pacific Coast Highway, the City of Long Beach during 1959 opened to public traffic extensive roadway and bridge construction as far south as Broadway. This construction, designed and financed by the City of Long Beach, has done much to provide adequate terminal facilities for the Long Beach Freeway and has greatly facilitated traffic movements in this area.

Long Beach Freeway Extension

The Long Beach Freeway Extension northerly of the Santa Ana Freeway will ultimately provide an eight-lane full freeway between the San Diego Freeway in Long Beach on the south and Huntington Drive near Alhambra and South Pasadena on the north.

The current contract extends the freeway from its present northerly terminus at the Santa Ana Freeway to 0.2 mile north of the San Bernardino Freeway, a distance of 3.74 miles.

Upon its completion in early 1961, the new link will serve to reduce congestion in the metropolitan Los Angeles area by providing a more direct route between the San Gabriel Valley communities and the cities located between Los Angeles and Long Beach. It will then be possible, for example, for a resident of West Covina to travel via the San Bernardino and Long Beach Freeways to the harbor area without being compelled to "run the gauntlet" through downtown Los Angeles and the already crowded freeways in the Civic Center area.

Webb and White, R.B. Potashnick and W. J. Disteli, with a contract allotment of approximately $6,651,500, began work on February 11, 1959, in the existing rubbish dump paralleling Laguna Wash toward the northerly section of the project. In this area, approximately 295,000 cubic yards of refuse material was removed to the disposal area immediately adjacent to the freeway. This work was necessary in the early stages to permit the construction of a concrete lined channel and reinforced concrete box culverts to relocate Laguna Wash. Continuous maintenance was required to control fires started by spontaneous combustion as the rubbish excavation operation progressed.

The first order of work was the excavation and grading of the Higgins local material site located just south of the San Bernardino Freeway. A timetable for grading designated areas there assured relocation of the brickyard facilities without undue disruption of production operations. To date, grading operations have proceeded according to schedule, and the Higgins Brick Company yard has been relocated with a minimum of disturbance.

Detours were constructed at the Third Street separation and the Humphreys Avenue, First Street and Brooklyn Avenue overcrossings before the existing streets were closed for the construction of bridges. Work is proceeding on schedule on all of these structures, as well as on the bridge over Whittier Boulevard, and on the various structures in the San Bernardino-Long Beach Freeway interchange area. There are a total of 13 bridges on the project, with the various types including welded steel girder, reinforced concrete box girder, and precast prestressed concrete box girder. Bridge lengths vary from a 70-foot single span to a 15-span structure with a total length of 1,135 feet, and foundation treatments vary from spread footings to concrete and steel piles.

In the San Bernardino-Long Beach Freeway interchange area, limitations on the sequence of operations assure uninterrupted traffic flow on the San Bernardino Freeway and on Ramona Boulevard (the existing South Frontage Road). During the period in which the 70 precast girders are placed and the falsework erected for structures across the San Bernardino Freeway, traffic will be detoured around the construction area between the hours of 1 a.m. and 5 a.m. Bridge construction includes a project total of 20,190 cubic yards of class A concrete, 4,140,000 pounds of bar reinforcing steel and 654,000 pounds of structural steel.

The highway portion of the work includes a total of 2,036,200 cubic yards of roadway excavation, with 56,885,400 station yards of overhaul. There is an additional source of material north of the San Bernardino Freeway, which may be used after the excavation in the Higgins Brick Yard area has been completed.

Before such additional material may be hauled from the area north of the San Bernardino Freeway, the southbound separation structure and Ramona Extension structure must be adequately reinforced and protected from damage by overloaded carry-alls.

Material selected from roadway excavation between Hubbard Street and Hammel Street, and material from structure excavation from the county storm drain has been designated for use as subbase material over the entire length of the project. Since the contractor also has the option of producing structure backfill material from the roadway prism, the importing of material is required only for the untreated base and surfacing.

Also included are 43,000 cubic yards of structure excavation and 68,000 cubic yards of structure backfill, with excavation for several large structures being paid as roadway rather than structure excavation.

Erosion control work will be done, with straw and seed application to all medians and freeway embankment and excavation slopes for a total of 285,000 square yards. Installation of sprinkler

line cross-overs will be made during the course of this project, available for future construction of a sprinkling system.

From the latest 1959 traffic counts, the average daily traffic on the Long Beach Freeway near Pacific Coast Highway is 52,000 vehicles.

Marina Freeway

A section 3.9 miles long in the Culver City-West Los Angeles area was adopted on December 16, 1959 as a freeway by the California Highway Commission. The estimate of cost for ultimate development to eight lanes is $30,800,000 for right-of-way acquisition and construction. The Marina Freeway will provide traffic service for the motorists using recreational facilities in the Santa Monica Bay area, and it could eventually serve as a part of the East-West Slauson Freeway which was included in Senate Bill 480.

Newport Freeway

This state highway route was declared a freeway by action of the California Highway Commission for various units between the years 1947 and 1954. Between Newport Beach and Costa Mesa for 3.3 miles the route has been completed to expressway standards.

For a length of 2.7 miles in and adjacent to the City of Costa Mesa between 19th Street and Palisades Road, Contractor R. J. Noble Company is now engaged in construction of the west frontage road which will later adjoin the ultimate six-lane freeway. By carrying out this construction now, it will be possible to operate this portion of the route as a four-lane divided highway by utilizing the existing pavement for northbound traffic and the west frontage road now under construction for southbound traffic. The contract allotment is $568,000.

Designs are now being completed on the portion of the Newport Freeway between the Santa Ana Freeway and its junction with the Riverside Freeway. For this 8.4 miles, the 1960-61 fiscal year budget contains an item of $8,800,000 for construction of a four-lane freeway. It is anticipated that this project will be advertised during the early part of 1961.



The relocation of a section of U.S. 101 Alternate in the Pacific Palisades slide area has been completed.



An aerial view westward of the San Bernardino-Golden State Freeways interchange east of downtown Los Angeles.



This aerial view westward shows a new section of the Riverside Freeway in Orange County with the Placentia Avenue overcrossing in the foreground.

Ojai Freeway

A section of the Ojai Freeway between existing US 101, in the City of Ventura and 0.4 mile south of Mills School was completed to four-lane freeway standards in 1956.

Preliminary plans for improving the section between 0.1 mile south of the Southern Pacific Railroad tracks and Foster Park have been completed insofar as the geometric design and grades are concerned. This permits protection of the right-of-way in areas where commercial developments are active.

Studies are now in progress looking toward the location for this freeway extending from Foster Park to the City of Ojai. As soon as these studies are completed, a public meeting will be held to inform the public officials, property owners and interested parties as to the details.

Pomona Freeway

The California Highway Commission on October 28, 1959, adopted a freeway routing for 2.3 miles of the Pomona Freeway in the Monterey Park-Montebello area between Woods Avenue and Potrero Grande Drive. This recent adoption together with the previously adopted portions by actions of the California Highway Commission on April 21, 1954; April 20, 1955; June 21, 1955, and November 20, 1958, completed the location of the freeway betweeen the Santa Ana Freeway and Pomona.

Aerial surveys are under way on the recently adopted portion and preliminary design work has been started. Design work is continuing on the westerly portion between the Santa Ana Freeway and Woods Avenue, and discussions have been held with the City of Los Angeles and Los Angeles County relative to freeway agreements.

Freeway agreements covering the easterly portion between Potrero Grande Drive and Brea Canyon Road (Route 19) have been executed with Los Angeles County and presented to the City of Industry. The easterly portion of this route, which traverses the San Gabriel Valley in the vicinity of the City of Industry, is currently in a transitional stage from agricultural usage to industrial and residential usage. Close co-operation between the Division of Highways design engineers and the local governmental engineering staffs and the engineers for the property owners engaged in development has worked out to mutual advantage of all parties concerned by coordination of design efforts. This is a good example of the mutual benefits obtained when there has been adoption of a freeway location by the California Highway Commission well in advance of private property developments.

Pacific Coast Freeway

From the City of Oxnard in Ventura County, 18.1 miles of US 101 Alternate has been adopted by the California Highway Commission as a part of Pacific Coast Freeway. Of this section, the northerly 7.2 miles from the City of Oxnard to Calleguas Creek was completed to full freeway standards November 15, 1957, at a cost of $2,400,000.

In 1955, at the time a state beach was being developed along this highway in Orange County, the Highway Commission adopted a 4.5-mile length of Pacific Coast Freeway from Huntington Beach to Newport Beach. The purpose of this adoption, upon which as yet no construction has been carried out, was to protect this state highway so that its effectiveness as a traffic-carrying artery would be preserved.

Another section, also in Orange County, 0.7 mile in length, was adopted by the California Highway Commission to provide an extension of this route to connect with the new San Diego Freeway at Serra Junction in the vicinity of Doheny Park. Construction in the estimated amount of $117,000 is now being carried out on this unit in connection with the contract now under way on the San Diego Freeway from San Clemente to San Juan Capistrano.

During 1959, the consulting firm of Moran, Proctor, Mueser, & Rutledge completed comprehensive investigations and studies of landslide conditions along the Pacific Palisades and in adjacent areas to the Pacific Coast Highway in the Cities of Santa Monica and Los Angeles and in the Los Angeles County area for a short distance to the west of the incorporated areas. This engineering study of sliding conditions in the Santa Monica area was author-

ized by the 1957 Legislature which provided the sum of $300,000 for this purpose. A copy of the report has been filed with the State Legislature. The State Department of Public Works in co-operation with the Cities of Santa Monica and Los Angeles, and the County of Los Angeles is currently preparing a review thereof which will also be presented to the Legislature. This study will provide comprehensive engineering data which will be valuable in determining future development of properties along the Palisades as well as of Pacific Coast Freeway.

Pasadena Freeway

The Pasadena Freeway is 8.2 miles in length, extending from the four-level structure near the Los Angeles Civic Center to Glenarm Street in Pasadena. The first unit, a six-lane freeway, was completed and opened to traffic on December 30, 1940. The last unit of construction on this freeway was completed and opened to traffic on September 22, 1953. The total cost of the Pasadena Freeway was $11,800,000.

The southerly two miles of this freeway that is referred to as the Elysian Park section is an eight-lane freeway and it is now carrying, according to the 1959 traffic count, an average daily traffic, of 118,000 vehicles.

At the southerly end of the Pasadena Freeway, 1959 traffic counts indicate the average daily traffic using the four-level interchange system with the Harbor and Hollywood Freeways to be 324,000 vehicles.

Riverside Freeway

The Riverside Freeway was officially named by the California Highway Commission in October 1957. The 19.1 miles in District VII comprise portions of State Highway Routes 175 and 43 from junction with the Santa Ana Freeway near Buena Park to the Riverside county line. There are 6.1 miles of full freeway and 13.0 miles of expressway in this district.

The last section of construction, 2.7 miles in length, extending from Spadra Road in Fullerton to Placentia Avenue in Fullerton and Anaheim, was opened to public traffic November 18, 1959. This was the last unit of construction to complete the Riverside Freeway either as a four-lane expressway or a four-lane full freeway throughout its entire length in this district.

The last unit of the Riverside Freeway was awarded under a 300-working-day contract to Ukropina, Polich, Kral and Ukropina on September 19, 1958, and was fully completed in January 1960. The contract allotment was $2,609,000.

Five of the bridges on this section are composite welded steel girders with reinforced concrete decks on reinforced concrete bents and abutments. The sixth, the Lemon Street Overcrossing, is of reinforced concrete box girder construction on reinforced concrete bents and abutments. All bents and abutments are on drilled cast-in-place concrete piles except for the bents of the Lemon Street Overcrossing which are on spread footings. At the North Anaheim Overhead the freeway crosses over the main line track between Los Angeles and San Diego of the Santa Fe Railroad and also over a branch line track of the Union Pacific Railroad.

The freeway is on embankment except at the westerly end where it is depressed at Lemon Street and Spadra Road. With the exception of approximately 80,000 cubic yards of roadway excavation obtained from the depressed freeway section near Lemon Street and from excavation at cross streets, embankments were constructed using imported borrow from various sources. part of the contract was the excavation of the Raymond Street Retarding Basin for the Orange County Flood Control District which provided 236,000 cubic yards of borrow. The basin site was approximately one-fourth mile south of the freeway. Approximately 135,000 cubic yards of borrow was obtained from the Placentia Avenue Retarding Basin, also owned by the OCFCD near the easterly end of the



Looking west along a new section of the Ventura Freeway through the Woodland Hills area in the San Fernando Valley. In the foreground is the Tapanga Avenue interchange.

project. Arrangements to obtain material from this site were made by the contractor. An additional 520,000 tons of imported borrow and imported subbase material were obtained from the site of a future settling basin on property owned by the Orange County Water District. Arrangements for use of this site for imported borrow were made by the State in advance of the contract and the use of this site was at the contractor's option. The site is approximately two miles east of the easterly end of the project and the material was hauled in bottom-dump trucks with semitrailer and trailer.

The volume of approximately 5,700 cubic yards of concrete used in drainage structures exceeded the 4,400 cubic yards used in the construction of the six bridges. In the vicinity of East Street a triple 10 x 7-foot reinforced concrete box culvert 760 feet in length was constructed across the freeway and East Street on new alignment of Carbon Canyon Wash Channel. On completion of the culvert the flood control district excavated an earth channel connection downstream to the Raymond Street Retarding Basin and an earth pilot channel upstream for a distance of approximately 1,500 feet to join the existing channel. Future improvement of this channel upstream is planned by the flood control district.

San Bernardino Freeway

The San Bernardino Freeway was completed throughout its entire length of 30.6 miles from the Santa Ana Freeway near the Los Angeles River to the San Bernardino county line in Claremont during 1956. A complete description of this freeway was given by District Engineer Lyman R. Gillis in *California Highways and Public Works*, July-August 1956. Since that time many improvements of a more or less minor nature have been made.

During 1959, in connection with the contract under way on the Golden State Freeway, a substantial improvement in the alignment of 1.4 miles of the San Bernardino Freeway has been completed and is now in use by public traffic. The curvature has been materially improved from the Macy Street Bridge to the Cornwall Street Bridge. The change in the alignment of the San Bernardino Freeway was necessary in order to work out satisfactory interchange facilities with the Golden State Freeway.

Early in 1960 it is expected that contracts will be started for widening projects on the San Bernardino Freeway for which there are allocations in the 1959-1960 fiscal year budget. These widening improvements are as follows:

San Dimas Avenue to San Bernardino county line—5.7 miles—widening from four lanes to six lanes—$1,500,000. (Bids opened January 28, 1959.)

Rosemead Boulevard to Puente Avenue—6.5 miles—widening from six lanes to eight—$2,250,000.

From Long Beach Freeway to Rosemead Boulevard—5.3 miles—widening from six lanes to eight—$2,000,000.

From the latest 1959 traffic counts, the average daily traffic on the San Bernardino Freeway in the vicinity of Soto Street is 112,000 vehicles.

San Diego Freeway

The route of the San Diego Freeway extends from junction with the Golden State Freeway near the San Fernando Reservoir on the north to the San Diego county line in San Clemente on the south. It is 90 miles in length. Portions of this route are constructed, under construction or budgeted for construction and on other sections of the route right-of-way is being acquired and freeway design is in progress. Two projects are under construction now: in West Los Angeles between Venice and Jefferson Boulevards, and in Orange County between San Juan Capistrano and San Clemente.

The West Los Angeles contract between Venice and Jefferson Boulevards consisting of an eight-lane freeway 2.32 miles in length was awarded to Guy F. Atkinson Company on October 17, 1958. The contract allotment is $5,257,500. The work includes grading and surfacing with portland cement concrete on cement-treated subgrade, nine bridges (all undercrossings) and 21 retaining walls; the major portion of the embankment is comprised of 1,050,000 cubic yards of imported borrow and originated from the Mulholland Summit Cut approximately 10 miles north of the contract limits. This cut is located at the crest of Sepulveda Canyon nestled in the middle of the Santa Monica Mountains at the intersection of the future San Diego Freeway and scenic Mulholland Drive. The Guy F. Atkinson Company was the third contractor to haul material from this site and the total yardage removed to date approximates 4,250,000 cubic yards with an equal amount remaining to be excavated under a future contract. The yardage involved approximates very closely the "Big Cut" of the Carquinez Bridge project (see the article in the January-February 1959 issue of *California Highways and Public Works*).

The design provides for 1:1 cut slopes with a 30-foot wide bench at every 60 feet in elevation or a 1½:1 basic slope with a maximum cut face of 310 feet just southerly of old Mulholland Drive.

To date three bridges on the West Los Angeles job are completed; three are in the deck construction stage; one in abutment wall construction; one in the pile drilling stage; and the remaining one being excavated to bottom of footing grades. The contractor anticipates paving operations to start in the middle of April 1960 with completion of the contract to be in June 1960.

Bids were opened on February 19, 1959, on a section of the San Diego Freeway in Orange County, between 1.4 miles south of State Sign Route 74 (Ortega Highway) in Capistrano Beach and Avenida Ramona in the City of San Clemente. The 7.7-mile contract, awarded on March 3, 1959, to Guy F. Atkinson Company at a bid price of $6,117,307, is expected to be completed in December 1960. The six- and four-lane freeway, work on which started on April 8, 1959, is being constructed on new alignment approximately one-half mile northerly and inland of present US Highway 101. Bridge construction, drainage structures and grading operations are the major items of work thus far, with the contract 35 percent completed. Drainage facilities include four reinforced concrete arch culverts.

In the 1959-1960 fiscal year budget, there are three allocations for construction on the San Diego Freeway that total $17,600,000, and in the 1960-61 fiscal year budget there are also three allocations for further construction on this freeway, that total $27,650,000, all six items of which are scheduled for advertising during the year 1960.

These allocations will accomplish the following:

(1) Completion of the San Diego Freeway through the Santa Monica Mountains to provide 14.3 miles of continuous freeway from Jefferson Boulevard in Culver City to Burbank Boulevard north of Ventura Freeway, and, in addition, provide for grading future freeway construction northerly from Burbank Boulevard to Nordhoff Street. Further grading for future freeway northerly from Nordhoff Street to the northerly terminus of the San Diego Freeway at junction with the Golden State Freeway will be done in connection with construction going forward in 1960 on the Golden State Freeway in this vicinity which is financed from 1960-61 fiscal year funds;

(2) Structures and approaches on the San Diego Freeway between Manchester Boulevard and Vesta Street in the City of Inglewood;

(3) Completion of a nine-mile length of the San Diego Freeway from 174th Street in Torrance to the Long Beach Freeway at the westerly outskirts of Long Beach. This will also include interchange facilities with the Harbor Freeway and the Long Beach Freeway.

Right-of-way acquisition is in progress financed from the $22,825,000 budgeted in the 1959-60 fiscal year. The extensive program of right-of-way acquisition on the San Diego Freeway will continue since the California Highway Commission in the budget for the 1960-61 fiscal year allocated $14,600,000 for rights of way on the San Diego Freeway.

The San Diego Freeway was completed and open to traffic from Burbank Boulevard to Valley Vista Street in San Fernando Valley (along with a portion of the Ventura Freeway), a distance of 1.2 miles, on July 3, 1958, at a construction cost of $2,838,000; on the West Los Angeles side of the Santa Monica Mountains, two miles were added between Casiano Road and Ohio Avenue in 1957 at a cost of more than $4,500,000; and on February 19, 1959, 3.6 miles were added between Ohio Avenue and Venice Boulevard at a cost of $6,190,400.

Considerably more mileage of the San Deigo Freeway has been constructed in Orange County since early



Looking northwest toward the Harbor Freeway with the Los Angeles downtown area in the foreground showing parking space areas which have become available as obsolete buildings are torn down.



Another section of the San Diego Freeway in Orange County has been completed. This southward view shows the Niguel Road-El Toro Road interchange.



An interconnecting roadway is being constructed between U.S. 101 (foreground) and the San Diego Freeway (background) in the Capistrano Beach area. The view is eastward.

1958, when a $899,000 contract extended it from junction with the Santa Ana Freeway near El Toro Marine Corps Air Station to Niguel Road. On August 13, 1959, an eight-mile section costing $4,099,900 was opened from Niguel Road to Trabuco Creek, where it joins another four-mile section through San Juan Capistrano completed on December 1, 1958, under $4,233,200 contract. The southernmost San Diego Freeway project through San Clemente to the San Diego county line, 1.8 miles, was completed on October 20, 1958, at a cost of $2,724,000.

San Gabriel River Freeway

Construction plans are now in preparation for the entire 22.6 miles of the San Gabriel River Freeway extending from the Garden Grove Freeway in Orange County to the San Bernardino Freeway in Los Angeles County. Interchange facilities will be provided between this freeway and the San Diego, Garden Grove, Artesia, Pomona and San Bernardino Freeways, as well as with major county roads and city streets.

This freeway passes through portions of the Cities of Norwalk, Santa Fe Springs, Baldwin Park, Long Beach, Downey and Industry. Freeway agreements have been executed by all of these cities and also Los Angeles County, except in the case of the City of Industry which now has the State's proposal under discussion with favorable action anticipated in the near future. Right-of-way acquisition, looking toward future construction when funds are available, is in progress.

Terminal Island Bridge

The Highway Commission on August 28, 1959, adopted as freeway the 1.6-mile length of the location routing for the proposed San Pedro-Terminal Island Bridge in Los Angeles County. This freeway route adoption extends from Harbor Boulevard in San Pedro to Mormon Street on Terminal Island. The action by the commission followed a public meeting held in San Pedro on June 25, 1959. Financing has been arranged including a proposed $6,000,000 revenue bond issue by the California Toll Bridge Authority. Rights-of-way are being acquired, and it is expected that this project, estimated to cost about $20,000,000, can go to contract in mid-1960.

Santa Ana Freeway

The Santa Ana Freeway is now completed throughout its entire length of 43.1 miles between the Los Angeles Civic Center in Los Angeles County and junction with the San Diego Freeway near El Toro MCAS in Orange County.

Two important items of reconstruction were completed during 1959 on the Santa Ana Freeway. Two bridges were built that were made necessary in connection with Orange County flood control developments that were completed on February 27, 1959, at a cost of $192,000. The necessary construction to convert the old four-lane freeway to six-lane width for 4.3 miles between Rosecrans Avenue and Buena Park, costing approximately $1,100,000, was completed May 12, 1959. The Santa Ana Freeway is now completed to six- and eight-lane standards between the Los Angeles Civic Center and the City of Anaheim, and to four-lane standards southerly thereof.

Included in the 1960-61 fiscal year budget is an item of $800,000 for widening the Santa Ana Freeway from six lanes to eight lanes from the Long Beach Freeway to Atlantic Boulevard. Relative to this widening a public meeting was held in Los Angeles on December 1, 1959. It is anticipated that this widening construction will be advertised early in 1960. From the latest 1959 traffic counts, the average daily traffic on the Santa Ana Freeway in the vicinity of Soto Street is 142,000 vehicles.

Santa Monica Freeway

The Santa Monica Freeway is 17.2 miles in length extending from the Santa Ana Freeway near Soto Street in East Los Angeles to Lincoln Boulevard in Santa Monica. It is a part of what is called "the Los Angeles Freeway Loop" and as such was described in detail by District Engineer Lyman R. Gillis' illustrated story published in the September-October 1959 issue of *California Highways and Public Works.* Since this story was written, the Peter Kiewit Sons' Company contract for bridge structures on the Santa Monica Freeway over the Los Angeles River and the Santa Fe and Union Pacific Railroads was completed and accepted December 1959.

Included in the 1959-60 fiscal year construction program are three projects on the Santa Monica Freeway extending from Eighth Street at the west end of the now completed Los Angeles River Bridge that is now completed to Oak Street, immediately west of the Harbor Freeway. Budget items for these three projects total $24,700,000. It is anticipated that contracts will be advertised for this construction, to be financed from 1959-60 fiscal year budget allocations, early in 1960.

In the 1960-61 fiscal year budget, there is an item of $5,000,000 to extend construction on the Santa Monica Freeway westerly for 0.4 mile from Oak Street to Hoover Street. It is anticipated that contract for this work will be advertised during the early part of 1961.

Engineering, design and preparation of contract plans are now in progress on all remaining sections of the Santa Monica Freeway from Hoover Street, Los Angeles, westerly to Lincoln Boulevard in Santa Monica. Right-of-way negotiations are also in progress. From Hoover Street to La Cienega Boulevard, at present writing, 36 percent of the necessary right-of-way has been obtained. On the section from La Cienega Boulevard to Lincoln Boulevard, 27 percent of the required right-of-way has been obtained.

Santa Paula-Santa Clara River Freeway

Two sections of State Sign Route 126 have been adopted as freeway by the California Highway Commission. These total 19.3 miles in length and extend from the Ventura Freeway to Orcutt Road near Santa Paula and from the Los Angeles-Ventura county line to US 99 near Castaic Junction.

For the freeway section between Ventura and Santa Paula, acquisition of right-of-way is proceeding rapidly. To date approximately one-fourth of the total of 330 parcels has been acquired. Construction plans for the 5.5-mile section between the Ventura Freeway and Wells Road are nearing completion. Contract plans for the easterly portion between Wells Road and Santa Paula are progressing rapidly.

Ventura Freeway

Design and preparation of contract plans continue on the Ventura Freeway between the west city limits of Los Angeles and the Santa Barbara county line to convert all remaining expressway sections to full freeway status.

Bids were opened February 11, 1960, for construction of a 4.6-mile section through the City of Ventura from 0.3 mile east of Telephone Road to Palm Street. The 1959-60 fiscal year budget contains an allotment of $9,341,000 to finance this construction. Another section to the west, three miles in length between Palm Street and the Southern Pacific Railroad Solimar Overhead, is tentatively scheduled for contract advertising in the summer of 1960. The 1960-61 fiscal year budget allocates $6,500,000 for financing this construction. Included in this latter project is an interchange and connection with US 399, the Ojai Freeway.

West of the Ventura River to the Santa Barbara county line, alignment has been set, including realignment out in the ocean at the Chanslor-Western Oil Refinery. Construction to four-lane freeway with right-of-way for six lanes is proposed. A public meeting was held on March 10, 1959, for the purpose of acquainting the public with plans for this section of US 101 north of the City of Ventura. At this same meeting sections of the Ojai Freeway, US 399, and the Coast Highway (US 101 Alternate) adjacent to the Point Mugu Missile Base were discussed.

On February 17, 1959, a two-mile link of full freeway in the San Fernando Valley area of the City of Los Angeles from the Hollywood Freeway at Moorpark Street west to Laurel Canyon Boulevard, at a construction cost of $4,466,400, was completed.

Currently there are two other projects under construction on the Ventura Freeway within the city limits of Los Angeles, in the San Fernando Valley.

The most easterly construction project on this freeway is that lying between Laurel Canyon and Sepulveda Boulevards, under contract since July 8, 1958, to Peter Kiewit Sons' Company. This project is 4.3 miles in length and was let at a contract bid of $8,898,472. In addition to the main Ventura Freeway, construction includes relocation of Mulholland Drive over the future San Diego Freeway through the Santa Monica Mountains.

Plans on the main contract call for grading, structures and paving eight lanes of concrete on cement-treated subgrade. Major contract items include 2,450,000 cubic yards of roadway excavation, 7,950,000 mile-yards of haul, 217,500 tons of imported subbase materials, 164,000 tons of untreated base, 51,500 cubic yards of concrete pavements in widths of 24 feet, 32,480 cubic yards of bridge concrete, 66,060 lineal feet of concrete and steel piling, 1,800,000 pounds of structural steel, 1.02 miles of sanitary sewer pipe, and 2.7 miles of storm drain pipe. The estimated completion date of this Ventura Freeway project is for late March or early April 1960.

Bids were opened on August 14, 1958, for a second construction contract on the Ventura Freeway between Encino Avenue and Kelvin Avenue in the City of Los Angeles, a distance of 3.9 miles.

The low bidder was Oberg Construction Corp. and Oberg Bros. Construction Company at $5,312,645.

Work consists of grading and surfacing for an eight-lane freeway with portland cement concrete on cement-treated subgrade, eight bridges, six pedestrian undercrossings and one pedestrian overcrossing. City streets were reconstructed where they join on and off ramps and Burbank Boulevard was reconstructed on new alignment to reduce the skew where the freeway crosses overhead. Completion is expected for the early part of April 1960.

The 1960-61 state highway budget contains $4,400,000 for construction of 2.2 miles of the Ventura Freeway from Buena Vista Street in Burbank east to junction with the Golden State Freeway at Griffith Park. This project will advertise for bids sometime during 1960.

In addition, construction funds have been budgeted for landscaping the Ventura Freeway from Colfax Avenue to the San Diego Freeway ($250,000) and from Encino Avenue to Kelvin Avenue ($240,000).

. . . Continued on page 65



A new slip-form paver in operation on the Vacaville-Dunnigan Cut-off (State Route 90) near Woodland.

Slip-form Paving

Hailed as Major Advance In Construction Practice

By LEIGH S. SPICKELMIRE, Assistant Construction Engineer

P.C.C. slip-form paving made its debut in California state highway construction during the late months of 1959, and immediately became the focal point of wide interest among highway engineers who see in the method not only a major advance in concrete paving practice but the potential of reduced paving costs.

Early last year the highway construction industry, represented by the Griffith Company of Los Angeles, proposed a demonstration of the capability of a slip-form paver manufactured by a California firm. Their plan was to pave a trial section in the Los Angeles River channel invert contract they then held with the Corps of Engineers under simulated highway conditions for evaluation by the Division of Highways. This proposal was accepted and as a result of critical review and testing of the 24-foot wide concrete slab constructed in that trial section Mr. G. T. McCoy as State Highway Engineer authorized the use of the slip-form paving method in state highway construction on an experimental basis.

Two paving contractors, Gordon H. Ball, Inc., of Danville and Griffith Company of Los Angeles, immediately requested permission to employ the revolutionary method on several of their going highway contracts.

Three Jobs Chosen

Contracts selected for the initial slip-form pavement construction in California were:

Contract 60-3TC9-FI, road III-Yol-90-A,B,Win., Gordon H. Ball and Gordon H. Ball, Inc., contractor. This project, located near Woodland, includes the construction of approximately 14 miles of two-lane 24-foot wide P.C.C. pavement, and in two interchange areas the ultimate four-lane divided section is being built, requiring 47,890 cubic yards of Class B concrete.

Contract 60-10TC4-FI, road X-Yol-90-A, Gordon H. Ball and Gordon H. Ball, Inc., contractor. This project joins the south end of the above contract at Putah Creek and extends the 24-foot wide two-lane P.C.C. pavement approximately six miles farther to the south, requiring 17,070 cubic yards of Class B concrete.

Contract 59-6TC10-F, road VI-Fre, Mad-4-C,A, Griffith Company, contractor. This project, located immediately north of Fresno, includes construction of approximately 15½ miles of 24-foot wide P.C.C. pavement, 7.705 miles of four-lane divided freeway, requiring 47,400 cubic yards of Class B concrete.

The two contracts with Ball which adjoin as indicated above, were adapted to a continuous paving operation from

one end to the other and were in many aspects equivalent to a paving project approximately 20 miles in length amounting to a total of 64,960 cubic yards of concrete.

Paver Described

The slip-form paver used consists essentially of two self-propelled crawler track assemblies with treads 20 inches wide and 18 feet long which support the main body through four heavy duty hydraulic rams, two at each track assembly. The main body consists of the structural support members, a traveling receiving hopper, a fixed full width feed hopper, full width transverse vibrating tubes mounted in the throat of the feed hopper, a primary screed or extrusion meter which is full width and 80 inches fore and aft, a secondary screed or transverse float which is full width and approximately 24 inches fore and aft, a transverse weakened plane joint cutting bar mounted between the primary and secondary screeds, slab depth side forms 15 feet long beneath the main body, a "V"-shaped finish float at the rear, a longitudinal weakened plane joint cutter mounted near the apex or leading end of the "V" float, a timing device at the rear of one track assembly for automatic interval control of transverse weakened plane joints, a 100-kva. diesel generator power supply, a control panel for the operator, and an electrical guidance system. Multiple lengths of trailing forms 15-feet each are attached as necessary to the rear end of the side forms beneath the main body.



A tensioned piano wire is installed to guide the slip-form paver.

Reinforcing Steel Used

In order to provide for installation of 30-inch lengths of No. 4 reinforcing steel as tie bars across the longitudinal center joint an apparatus was developed on the job prior to start of work on the initial District III contract. This apparatus attaches to the front plates of the feed hopper and consists of two reels of baling wire and a drum guide arrangement.

The device is designed to feed two strands of baling wire over the guide drum and into the center of the slab at middepth. Adequate room is provided between the reels of baling wire and drum guide for an operator to affix tie bars at 30-inch intervals by twisting a strand of baling wire around each end of the bar.

Steady but light tension is maintained in the baling wire by the forward advance of the paver operating against the resistance of previously installed bars.

Perhaps the most important distinguishing characteristic of this slip-form paver is the guidance system which maintains the machine on predetermined alignment and grade for the completed pavement.

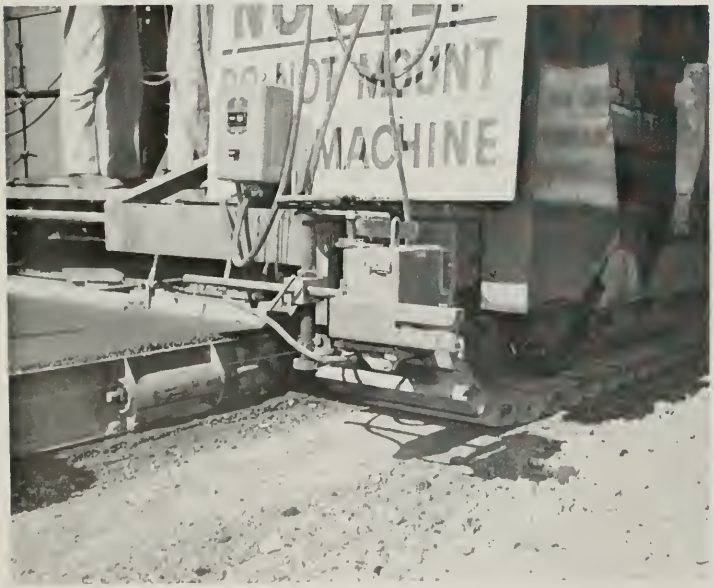
Such guidance is accomplished through the use of a meticulously accurate installation of two lines of tensioned 16- or 18-gage piano wire at pre-established and constant lateral and vertical offset from each edge of pavement. These wire lines serve as guides for the paver.

Feelers Actuote Switches

Sensing elements which operate along these wire guides are attached to the main body of the paver and consist of a slotted feeler, which straddles the wire, together with sensitive limit switches which are actuated by the feelers.



A close-up at the paver showing the left front elevation control probe passing by a stake with the steering control probe just behind the stake.



A close-up of the right rear elevation control probe on the slip-form paver.

Five of these sensing elements, or probes as they are referred to, are used. Four are mounted with the feeler in horizontal configuration and furnish elevation control while one element is mounted with the feeler in vertical configuration for steering control.

Probes for elevation control are mounted at each corner on the main body by extension arms which position the elements around and clear of the track assemblies so that the feelers are over the wire guides.

Each elevation control probe triggers the operation of one of the hydraulic rams. When a signal is transmitted from any one of the probes the hydraulic ram corresponding to the position of that probe either raises or lowers. In raising or lowering, the ram moves the corresponding corner of the main body of the machine up or down which, since the probe is attached thereto, repositions the probe in relation to the wire guide and ends the signal for correction. As the main body of the machine raises or lowers the screeds are raised or lowered also because they are attached integrally thereon.

The cumulative effect of the operation of all four elevation control probes is to continuously maintain the screeds of the paver in proper attitude and position in respect to the preset wire guides.

Automatic Control

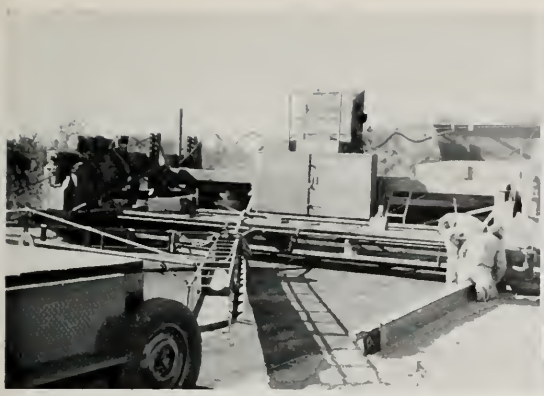
Alignment or steering control is provided through the operation of one probe which can be mounted at either forward corner of the paver. This probe furnishes control automatically over the differential speed of the two independently propelled track assemblies.

Subgrade Preparation

Gordon H. Ball, Inc., forces began construction of cement treated subgrade on the job near Woodland (60-3TC9-FI) in September and completed this work for the entire contract, 210,000 square yards, in eight working days. All C.T.S. construction was performed before starting the paving operation.

Subgrade construction consisted of cement treating four inches of 1½-inch maximum untreated base aggregate, 26 feet wide.

Elimination of side forms by the slip-form operation enabled construction of the cement treated subgrade 12 inches beyond the edges of the



A rear view of the slip-form paver.



The belt conveyor discharge for the paving mixers.

concrete pavement on either side for better control of edge pumping by the completed slab.

The material to be treated was already in place on the roadway. Thus construction procedures consisted of: (1) bringing the top of compacted untreated material to proper grade and cross-section; (2) loosening and forming the top four inches into two equally sized windrows side by side on the roadbed; (3) distributing the proper quantity of cement into notches formed in the top of each windrow; (4) mixing; (5) spreading and compacting; and (6) finish grading to final grade and cross-section.

Normal procedure for header board paving involves similar general procedures for subgrade construction; however, conventional subgrading equipment operates on the side forms. For slip-form paving such side forms are not used and different methods become necessary. Furthermore, very accurate subgrade both under the track assemblies as well as under the pavement is needed for optimum performance of the paver and minimum overrun of concrete quantities.

Longitudinal Space Reduced

Ball's method was to do initial grading and windrowing with a motor grader operated to blue tops set by his forces from the engineer's control stakes. Control stakes were set at the lateral offset of 3.71 feet, which would conform to the offset of the control wire to be installed for the subsequent paving operation, at the elevation for bottom of pavement, and at 50-foot interval along line. Where vertical curves were encountered the longitudinal interval between control stakes was reduced to 25 feet.

Cement was distributed on the windrows with a distributor and mixing was accomplished with a large self-propelled road mixer. Initial spread of the mixed subgrade materials was accomplished with a spreading device on the mixer.

Following initial compaction a tractor-towed spreader with automatic hydraulic controls for control of cross-slope and longitudinal grade was employed to perform finish grading.

During the operation of this tractor-towed automatic spreader, Ball's stak-



A tractor-towed spreader with automatic hydraulic controls does the finish grading of cement-treated subgrade.



A triple batch plant set up for the Vacaville-Dunnigan Cut-off project near Winters.



A rear view of a mixer discharging cement-treated subgrade material.



A front view of a mixer for cement-treated subgrade showing the bucket conveyor.

ing crew kept constant check of both the finished grade and the cross slope by use of templates.

With the application of an asphaltic curing seal the subgrade was ready for pavement construction.

Construction of cement treated subgrade by Griffith Company on their contract near Fresno varied from that described above. In this instance the materials to be treated were not already in place when the operation was started but were imported and spread in a single windrow through an enlarged spreader box as part of this phase of work. Cement was distributed to this single windrow with a distributor similar to that used by Ball; however, the most significant change was in the equipment used for mixing.

Assemble Self-propelled Unit

In order to mix the outsized windrow comprising all materials for a 4-inch-deep treatment 26 feet wide, Griffith employed a self-propelled

pugmill mixer assembled by their own forces.

This unique machine, labeled irreverently by someone as "the Monster," elevates all materials in the windrow by bucket conveyor onto an overhead enclosed belt which feeds the forward end of a double-shafted pugmill mixer. Mixed materials are discharged onto the subgrade in twin windrows.

Spreading and compaction is performed conventionally with blade and rollers and final grading is performed to blue tops by a blade with automatic control.

Paving Operation

For his jobs in Districts III and X, Ball utilized a triple batch plant. Initially this plant was charged by a single clamshell shovel. During later stages of the work a belt conveyor was added for charging the sand.

Pay Loads Maintained

For transporting the dry batches to paving mixers on the grade Ball utilized his big fleet of fast and large batch trucks with specially designed six-batch bodies. This efficient lineup of batch trucks with their driver-controlled air-actuated batch gates and big pay loads maintained a fast-paced schedule and eliminated the conventional dump men at each mixer.

Mixing was performed by a pair of dual drum pavers. And, in keeping with the multitude of other innovations on these three spectacular jobs, each mixer was modified to discharge the mixed concrete by belt conveyors instead of the usual bucket.

These 30-foot self-driven belt conveyors were specially constructed and were mounted on reinforced booms controlled by the mixer operator.

The two mixers are operated on the pavement subgrade side by side immediately in advance of the slip-form paver. Openings at approximately 500-foot intervals are made in the wire guides to permit ingress and egress of the batch trucks which line up on the subgrade in front of the mixers.

As paving progresses this entire equipment train progresses down the grade at approximately eight feet per minute. When one opening in the wire guide is passed by the batch trucks and another is opened up, workmen quickly splice in the missing portion of wire and the operation continues without interruption.

The slip-form paver with its insatiable appetite sets the pace for the entire operation.

Each mixer moves forward six or seven feet between each batch while the skip is in the up position. This puts them in position to discharge the succeeding batch into the receiving hopper of the slip-form paver while the mixer is stationary and the paver steadily advancing.

Delivery Rate Varies

In order to compensate for variations in the rate of delivery of mixed concrete the paver is provided with controls at the operator's position for varying the speed from zero to maximum paving speed of approximately 15 feet per minute. This is a rheostat control for electric propulsion motors with smooth and infinite change of speed within the range. Maximum forward travel speed is 32 feet per minute.

Upon discharge of concrete into the receiving hopper the operator distributes it laterally into the feed hopper below by propelling the receiving hopper from side to side and opening the gate thereon.

Concrete is vibrated from the feed hopper under the primary screed and



A close-up of the slip-form paver showing the right rear hydraulic ram in the center of the photo.



A device for installing reinforcing steel as tie bars across longitudinal weakened plane joints.



A paving mixer charging the slip-form paver during operations on the Vacaville-Dunnigan Cut-off job.

consolidated into place as the paver moves forward.

At pre-established intervals, as determined automatically by the timing unit, a vibrating tee iron transverse joint cutter is hydraulically rammed into the fresh concrete. This produces a ⅜-inch-wide groove approximately three inches deep in the pavement. Since the joint cutter is located between the primary and secondary screeds the second screed irons out any irregularity in the surface caused by cutting the groove.

Immediately behind and centered on the secondary screed a vibrating tool is installed to cut the longitudinal centerline joint. This device produces a groove approximately ⅜-inch wide and two inches deep down the center of the 24-foot wide pavement.

Trailing Forms Needed

Attached to the side forms beneath the main body of the paver are 30 to 45 feet of trailing forms on each side. Actually the length of trailing forms can be varied readily by simply attaching additional lengths. Under the conditions encountered on the District III and X jobs it was found that 30 feet of trailing forms is adequate.

Floating freely on the surface of the fresh pavement between the trailing forms a "V"-shaped float is towed by an attachment at the apex. This chevron float acts to establish the desired finish on the pavement and floats out many minor deviations particularly at the transverse weakened plane joints.

Attached just aft of the apex of the chevron float a simple jointing tool finishes the longitudinal joint which on the Ball contracts was left an open groove.

Edging and any necessary hand-floating and finishing is performed between the trailing forms and behind the chevron float.

One burlap drag attached to the rear trailing form cross brace followed by a second burlap drag pulled by hand 10 or 15 minutes later completes the finishing operation.

Curing Seal Applied

A pigmented compound is applied by hand-operated spray bar at one gallon per 150 square feet as a curing seal. To enable the spray operator to be in position to reach both sides of the pavement a self-propelled bridge is used. The traveling bridge is steered by a simple braking system through an automotive rear axle drive assembly. Efficient operation requires one oper-



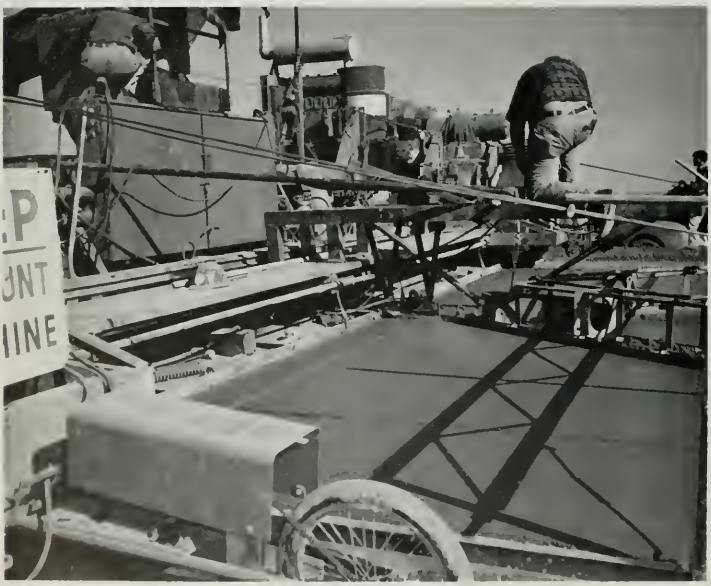
Hand-finishing and edging between the trailing forms.



Applying pigmented curing compound from a self-propelled bridge.



A view of the paver showing the "V" float between the trailing forms.



A close-up of the paver showing a device cutting longitudinol weakened plane joint at the center of the picture.

ator to steer and one to apply compound.

Job superintendent for Gordon H. Ball on his District III contract for $1.4 million is Merrill Dubach; paving superintendent is Bill Appel; and paving foreman is Bill Southworth. Hal Lopez is resident engineer for the State Division of Highways, and Bill Cruthirds is paving inspector.

Ball's personnel on the District X contract for $1 million are the same, and George Demetrus is resident engineer for the State, with Don Pontius as paving inspector.

Job superintendent for Griffith's contract for $3.2 million in District VI is Ernie Arant; paving superintendent is Gordon McGrew; and paving foreman is J. Bittner. Nelson Humiston is resident engineer for the State, and Carl Haney is paving inspector.

Smoky Buses, Trucks Will Be Controlled

Governor Edmund G. Brown has announced a campaign to remove "visible smoke and oily soot from smoky buses and trucks" from the State's highways, especially where they pass through populated areas.

He said he is making an urgent request to trucking firms and bus operators, asking them to bring all such vehicles into compliance with existing state laws on the subject by February 15, 1960.

The Governor said he has set that date for a stepped-up enforcement campaign by the California Highway Patrol.

Governor Brown said that he has been assured by technical experts that excessive smoke can be cleared up by proper engine adjustment, and, in the case of some diesels, by proper fuel.

He said the 60 days between December 15 and February 15 would give operators plenty of time to make necessary adjustments to comply with the law. The Governor said that adequate methods of measuring smoke density are already in use by the California Highway Patrol.

California Highways...1959

An Annual Report

By J. C. WOMACK, State Highway Engineer

The report which appears on pages 29 through 44 basically covers the 1958-59 fiscal year, but has been revised to include important developments extending to December 31, 1959. Copies of this report may be obtained upon request.

CALIFORNIANS have built a thriving economy and a bountiful way of living on a foundation of mobility—freedom of movement afforded by millions of cars and trucks.

Favored with diverse industrial resources, expanses of rich farmland, vast recreational areas, and a mild and generous climate, the people of this State have called upon motor transportation and good roads to bind these assets into a great and dynamic society.

Today the automobile has an essential role to play in nearly everything Californians do. The family car serves as a combination shopping cart, commute bus, dump truck, and vacation liner; and heavy transport vehicles and smaller trucks carry produce, raw materials, and goods to the manufacturer and the merchant.

These close ties between motor transportation and day-to-day living help to explain why there are more cars and trucks in California than in any other state.

Motor vehicle registration is now nearing the 8,000,000 mark, slightly more than one car or truck for every two of the State's 15,550,000 citizens. Last year Californians traveled an enormous total of 65 billion miles on the State's roads, streets, and highways.

The present reliance on highway travel will become even greater as the State's population and traffic continue to increase.

Conservative estimates indicate that by 1980 there will be twice as many cars and trucks as now on the road in California, and the number of miles covered each year on the State's roads, streets, and highways will be about three times greater.



This new section of U. S. Highway 40 sweeps in graceful curves through the rugged terrain of the Sierra-Nevada east of Colfox. Several large-scale freeway projects were completed on this major Interstate Highway in 1959.

Recognizing the importance of adequate highways to serve the acute motoring needs of the present, as well as the demands of the future, Californians have given continuing support to an extensive program of state highway improvement while exploring additional methods of transportation such as rapid transit.

On the basis of several comprehensive traffic and financing studies since World War II, the State Legislature

has implemented pay-as-you-go highway development through realistic user taxes.

A recent overall study of this type was the basis for the California Freeway-Expressway System which was adopted by the 1959 Legislature. This statewide master plan calls for construction by 1980 of a 12,400-mile network of controlled access highways reaching into every corner of the State.

While exerting leadership in these long-range planning matters, the Legislature has continued to delegate to the California Highway Commission the authority and responsibility for determining highway routes and allocating construction funds.

These legislative policies have insured the continuity of the highway program, making possible the steady and orderly construction progress which has given California a system of highways often described as the best in the nation.

Today, California has more miles of toll-free multilane divided highway than any other state, and work is going ahead on new improvements as the State strives to keep pace with its still mounting highway needs.

The State Division of Highways, a unit of the Department of Public Works, handles the day-to-day administration of California's highway program, working in conformance with state law and policies of the Highway Commission. The division is in charge of all state highway planning, design, right-of-way acquisition, construction and maintenance. Its activities cover the entire range of highway work from large scale freeway and bridge construction to small but essential maintenance jobs.

State highway development and operation for the fiscal year ending June 30, 1959, are reported in the 13th Annual Report to the Governor by the Director of Public Works. That report contains sections on each phase of the highway program. It also includes detailed financial tabulations, contract statistics, and other data.

Some of this information, together with other more recent data, is included here.

In 1959 there were significant developments in the major areas of financing, planning, construction, and highway research:

1. California suffered a $70-million setback, largest of all the states, as federal financing for the National Interstate Highway Program was cut back sharply.

2. Long-range prospects for highway development were brightened, however, when the Legislature adopted the monumental California Freeway-Expressway System master plan (Senate Bill No. 480).

3. Many long-awaited highway projects were completed, under construction, or budgeted to close freeway gaps on heavily traveled through routes or provide new links in the basic freeway networks of metropolitan areas.

4. The Division of Highways completed an important phase of continuing research on development of center strip barriers as a means of further improving the already favorable safety record of the State's freeways.



This new stretch of highway on State Sign Route 41 near Shandon in San Luis Obispo County was one of the many highway improvements completed last year in rural and scenic areas of California.

Financing Emergency

California's highway program weathered a period of acute uncertainty about federal financing in 1959 due to shortages in the national highway trust fund. Prospects for a time were so uncertain that it was necessary to suspend advertising for bids on new highway projects.

With the largest stake in the interstate program of any of the states, California faced the possibility of seeing its federal interstate highway apportionment plummet from $250,000,000 for 1959-60 to nothing at all for 1960-61.

Fortunately, this threatened total reduction did not come about. A partial solution to the federal financing dilemma was finally worked out in Washington. This compromise financing method, however, left California with about $70,000,000 less in federal funds than had previously been counted on for the 1960-61 fiscal year.

When the 1960-61 federal apportionment for interstate highways was announced last October, it included only about $180,000,000 for California instead of the $250,000,000 which had been expected under the schedule set by Congress in the Federal Highway Acts of 1956 and 1958.

The extensive revision of plans and schedules necessitated by the reduced federal apportionment is reflected in the 1960-61 State Highway Budget adopted in October 1959 by the Highway Commission.

Many important projects have been delayed. Right-of-way acquisition has been curtailed. The orderly processes of advance planning have suffered.

As Director of Public Works Robert B. Bradford pointed out in a recent address, the immediate federal financing crisis is ended and there is reason to believe that the interstate highway program will now go ahead on a sound basis and gradually regain its lost momentum.

"Some time in 1960," Director Bradford said, "we expect to be notified of our federal interstate apportionment for the 1961-62 fiscal year. We hope it will be based on a firm foundation. Certainly nobody wants to repeat the confusion and controversy of 1959. We know that congressional studies of various phases of the program, including financing, are under way, and we trust they will produce some sound fiscal results."



Freeway and expressway development on U. S. Highway 101, one of the State's main north-south traffic arteries, is proceeding at a rapid pace. This section of expressway in northern Mendocino County was opened last year.

Freeway-Expressway System

California became the first state to have an official long-range master plan for a statewide network of limited access highways on June 19, 1959, when Governor Edmund G. Brown signed legislation establishing the 12,400-mile California Freeway-Expressway System.

The plan calls for $10.5 billion in freeway and expressway construction during the next 20 years, assuming there is no change in the present highway financing structure. It was adopted by the 1959 Legislature in Senate Bill No. 480.

This measure was introduced by Senator Randolph Collier of Yreka, Chairman of the Joint Interim Committee on Highway Problems. It became effective September 18, 1959.

Governor Brown said the signing of the bill was "a momentous occasion in our State's history.

"This will eventually result in linking all cities of 5,000 or more persons, and it will carry 59 percent of the total vehicle travel when completed," the Governor said.

As adopted by the Legislature, the freeway-expressway system included 10,800 miles of highways which were already under state jurisdiction as part of the 14,000-mile State Highway System. An additional 1,600 miles of the freeway-expressway system routes were streets and roads maintained by cities and counties or new roads not yet built.

Over a 20-year period of use, the freeway-expressway system will return user benefits amounting to nearly twice the estimated $10.5 billion cost. This means savings in 20 years to the motoring public of some $20 billion.

Routes in the system have been designated by the Legislature in a general way. In most cases, only the termini have been named in law.

General legislative descriptions of this type will provide the guidelines for studies and public discussions leading to the adoption of more precise routes and decisions on details of design.

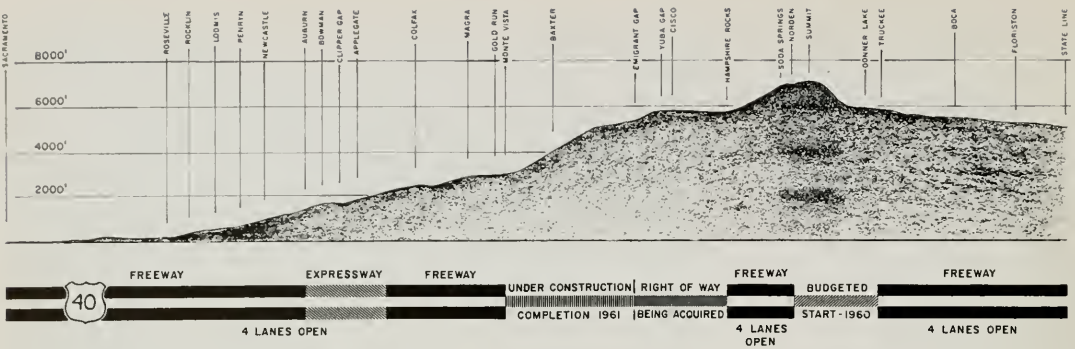
Standards for each of the routes, such as the number of lanes and the extent of access control, will vary with local needs and conditions. The type of facilities to be built will range from eight-lane full freeway in large population centers and on major through highways to two-lane expressways in sparsely settled areas where there is relatively little traffic.

Provision is also made for continuing review of the freeway-expressway system plans. The Division of Highways is required to submit a progress report to the Legislature every four years, beginning in 1963, and to suggest possible revisions as indicated by changing growth and economic patterns.

Suggested revisions are to be considered by the Legislature through its own committees and through advisory committees of city and county officials which the Legislature may appoint.

While work is progressing on routes included in the system, other state highways will not be neglected. The law calls for concurrent improvement of these highways according to relative deficiencies and traffic conditions.

Studies leading to the overall plan were requested by the 1957 Legislature in Senate Concurrent Resolution



No. 26. Two years of intensive work went into the plan, involving the most comprehensive analysis of motor vehicle traffic, population, and economic conditions ever developed in California for highway planning purposes.

The Division of Highways worked closely with other agencies in preparing the plan. A Legislature-appointed committee of city and county officials acted in a technical advisory capacity. County and city planning and engineering staffs extended full co-operation. The Automotive Safety Foundation of Washington, D.C., and the Institute of Transportation and Traffic Engineering of the University of California also assisted.

Construction Progress

Hundreds of highway construction projects were completed throughout the State in 1959, and at the end of the year many others were under construction or budgeted.

By the end of 1959, California had 2,147 miles of multilane divided highway in operation and another 235 miles under construction, as compared to 1,973 miles in operation and 359 under construction a year earlier. An increasing percentage of this divided highway mileage was of the full freeway or expressway type.

The construction emphasis continued to be on the development of full freeways. Experience with various highway designs, both in California and elsewhere, has repeatedly shown that freeways carry more traffic with greater safety than any other type of highway; and unlike other highways, the capacity of freeways is not reduced by the development of roadside businesses and subdivisions.

These longterm dividends result from basic freeway design features—control of access, the elimination of cross traffic and left turns in front of oncoming vehicles, and the separation of opposing traffic by a dividing strip.

Californians were driving on 760 miles of completed full freeways by the end of 1959. Another 187 miles were under construction.

Also in operation at the end of the year were 840 miles of expressway—divided highway with most of the features of a freeway, but with some intersections at grade.

Most expressways are designed for future conversion to full freeway status. A number of controlled-access two-lane highways (two-lane expressways) have also been completed in recent years, mainly in rural and mountain areas where traffic is comparatively light.

In the Los Angeles area large-scale freeway projects were completed in 1959 on the Ventura, Golden State, Riverside, San Diego, Santa Ana, and Santa Monica Freeways.

Current construction activity is being concentrated on a number of key routes in order to speed progress toward an integrated freeway network for the entire metropolitan region and to relieve traffic pressure on existing central area freeways in the vicinity of the Four-Level Interchange.

At year's end a spectacular series of high-priority projects was in progress or budgeted on the portions of the Golden State and Santa Monica Freeways which will form the long-planned "East Loop" bypass around the central district.

This close-in bypass will extend from San Fernando on the north to the Harbor Freeway south of the civic center, providing an alternate route for a great deal of the traffic now using existing downtown freeways.

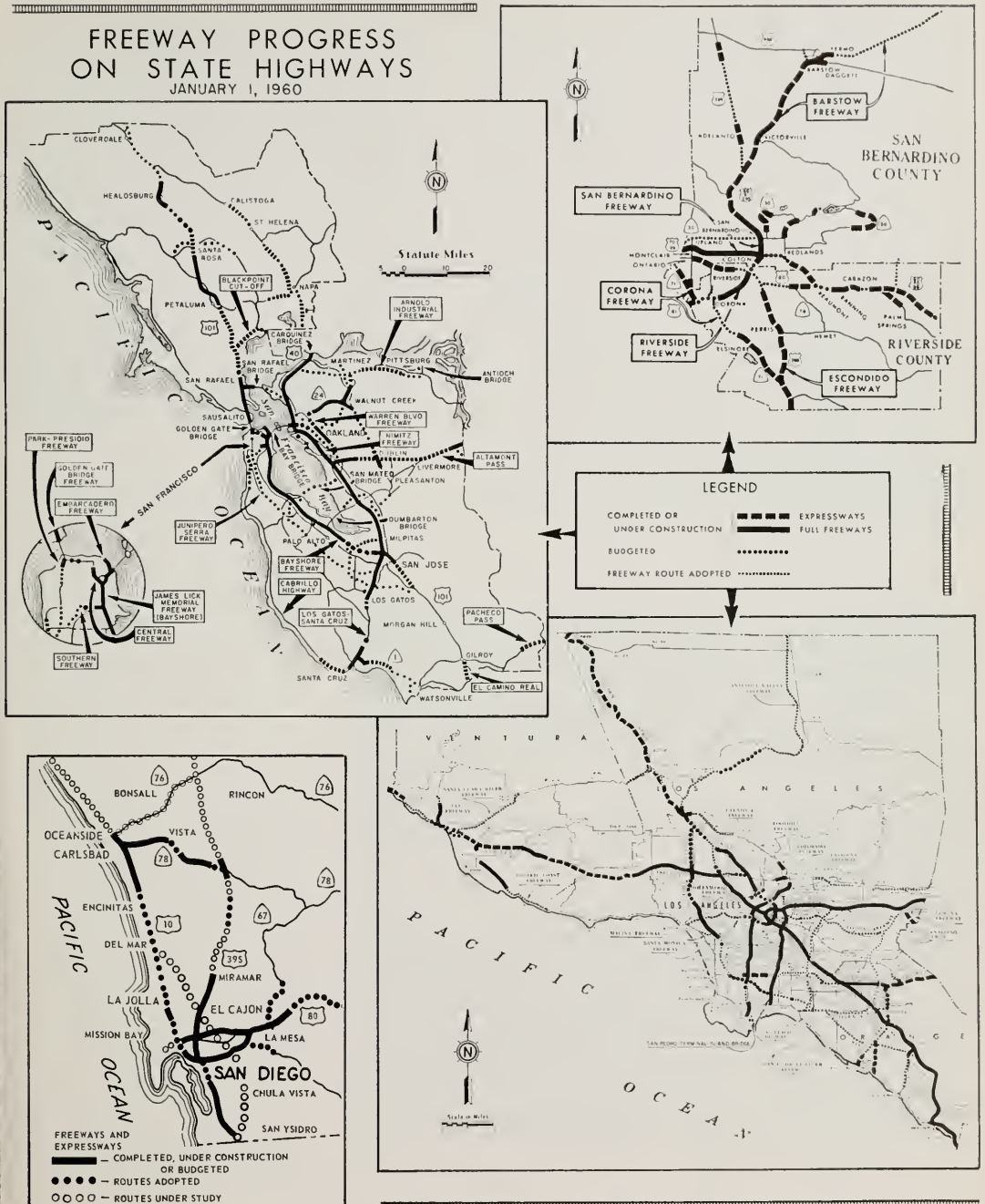
One of the most complex projects along this route was under way at the end of 1959—construction of the mammoth East Los Angeles Interchange. This interchange will connect the Golden State, Santa Monica, and Santa Ana Freeways and the proposed Pomona Freeway.

On the San Diego Freeway, another key route in the regional freeway system for the Los Angeles area, projects were in progress or budgeted to complete 14.3 miles of freeway from Culver City to north of the Ventura Freeway and nine miles from Torrance to near Long Beach. Considerable grading and structure work on other sections was also provided for in the budget.

Work was continuing on a project to extend the Long Beach Freeway from the Santa Ana Freeway to the

FREEWAY MAPS

The maps on these pages show the expanding freeway and expressway networks in the San Francisco, Los Angeles, San Bernardino-Riverside and San Diego areas as well as the status of U. S. Highway 40 from the San Francisco Bay area to the Nevada state line.


FREEWAY PROGRESS
ON STATE HIGHWAYS
JANUARY 1, 1960
CLOVERDALE
HEALDSBURG
CALISTOGA
ST HELENA
SANTA ROSA
PETALUMA
NAPA
BLACKPOINT CUT-OFF
CARQUINEZ BRIDGE
SAN RAFAEL BRIDGE
SAN RAFAEL
SAUSALITO
GOLDEN GATE BRIDGE
PACIFIC OCEAN
Statute Miles
ARNOLD INDUSTRIAL FREEWAY
MARTINEZ
PITTSBURG
ANTIOCH BRIDGE
WALNUT CREEK
WARREN BLVD FREEWAY
NIMITZ FREEWAY
OAKLAND
DUBLIN
ALTAMONT PASS
LIVERMORE
SAN MATEO BRIDGE
PLEASANTON
DUMBARTON BRIDGE
MILPITAS
PALO ALTO
SAN JOSE
BAYSHORE FREEWAY
CABRILLO HIGHWAY
LOS GATOS
LOS GATOS-SANTA CRUZ
MORGAN HILL
PACHECO PASS
GILROY
SANTA CRUZ
WATSONVILLE
EL CAMINO REAL
PARK-PRESIDIO FREEWAY
GOLDEN GATE BRIDGE FREEWAY
EMBARCADERO FREEWAY
SAN FRANCISCO
JUNIPERO SERRA FREEWAY
JAMES LICK MEMORIAL FREEWAY (BAYSHORE)
CENTRAL FREEWAY
SOUTHERN FREEWAY
BARSTOW FREEWAY
SAN BERNARDINO COUNTY
SAN BERNARDINO FREEWAY
CORONA FREEWAY
RIVERSIDE FREEWAY
ESCONDIDO FREEWAY
RIVERSIDE COUNTY
LEGEND
COMPLETED OR UNDER CONSTRUCTION
EXPRESSWAYS
FULL FREEWAYS
BUDGETED
FREEWAY ROUTE ADOPTED
VENTURA
LOS ANGELES
PACIFIC OCEAN
BONSALL
RINCON
OCEANSIDE
VISTA
CARLSBAD
ENCINITAS
DEL MAR
MIRAMAR
LA JOLLA
EL CAJON
MISSION BAY
LA MESA
SAN DIEGO
CHULA VISTA
SAN YSIDRO
PACIFIC OCEAN
FREEWAYS AND EXPRESSWAYS
— COMPLETED, UNDER CONSTRUCTION OR BUDGETED
— ROUTES ADOPTED
— ROUTES UNDER STUDY

San Bernardino Freeway. A job was also under way on the Harbor Freeway which will carry freeway development on this route southerly to 190th Street.

Two nearly completed sections on the Ventura Freeway in the San Fernando Valley and a third under construction on the San Diego Freeway in Orange County will close the remaining gaps in 90 miles of continuous full freeway on US 101 between San Clemente and the west city limits of Los Angeles. A freeway project on US 101 in the City of Ventura was advertised for bids late in the year.

The last expressway sections of the San Bernardino Freeway were converted to full freeway with completion of separation structures in San Bernardino County. Freeway sections were also completed through San Bernardino. A gap-closing freeway project on the Riverside Freeway was also completed between Colton and Riverside.

Several other large-scale projects were progressing in Riverside County, including freeway construction between Riverside and Corona. Nine miles of freeway was under construction on US 60-70-99 west of Indio, and a new bridge was being built over the Colorado River at Blythe. Work was beginning on a freeway through Barstow.

Bids were to be opened in February 1960 on a freeway project at Beaumont, and two newly budgeted projects will complete freeway development through Redlands on US 70-99.

In San Diego County work continued on the conversion from expressway to freeway on U. S. Highway 80 between San Diego and El Cajon, and work was completed late in the year on a freeway project on Sign Route 94.

Funds were budgeted for a portion of the north-south freeway on US 101 through San Diego and for freeway construction on Sign Route 73 near Escondido.

The rapid development of US 101 to freeway and expressway standards continued with new projects recently completed, under construction, or budgeted in each of the coastal counties between the Los Angeles area and the San Francisco Bay region, as well as in Marin, Sonoma, Mendocino, and Humboldt Counties to the north.

A long section of Sign Route 41-US 466 was improved to two-lane expressway standards in eastern San Luis Obispo County.

In San Francisco a new section of the Central Freeway was completed, and construction was going ahead on an initial unit of the Southern Freeway.

Bids were to be opened in January on the first unit of the MacArthur Freeway (US 50) in Oakland, and work was in progress on a second underwater tube (Webster Street Tube) between Oakland and Alameda. Funds were budgeted for an additional two-lane bore at the Broadway Tunnel on Sign Route 24 in Oakland.

Work started last year on the bond-financed Benicia-Martinez Bridge and approaches in Solano and Contra Costa Counties, and a contract was awarded in January on construction of an adjoining section of freeway on the Vallejo-Benicia Highway.

One project was completed and another nearly finished on the Vacaville-Dunnigan Cutoff (Highway Route 90) to provide the initial two lanes of a future freeway on a long section of this interstate route.

Between San Francisco and Sacramento nearly all of US 40 is developed to multilane divided standards. Projects to convert additional sections from expressway to freeway were budgeted or under construction.

Fast of the State Capitol more improvements were completed on this interstate highway in 1959 than in any previous year.

Five new sections of full freeway, totaling 37.5 miles, were opened to traffic. At the end of the year only 35 miles of the old two-lane mountain highway remained, of which 13 miles was being converted to freeway in two construction projects.

On US 99, the heavily traveled north-south valley route, new freeway sections were opened south of Sacramento, and structures and grading had been constructed on the South Sacramento Freeway with additional



A series of impact tests was conducted in 1959 in connection with continuing research into the possible use of barriers in the center strip on freeways. A fenco-coble barrier, shown as it successfully halts a radio-controlled sedan going 60 miles an hour, was one of the new barrier designs found to be most effective.





The design model (above) previews the future appearance of the East Los Angeles Interchange and the Los Angeles River Bridge (foreground) on the Santa Monica Freeway. Both are units of the future "East Loop" bypass. The interchange is now under construction, and the bridge (photo at right) was completed in 1959.

funds budgeted to complete this freeway section.

On the Stockton Bypass work was completed on some interchanges, and construction was also in progress on freeway units north of Fresno and on the Grapevine Grade in Kern County.

A new four-lane bridge to replace the old and substandard structure over the Yuba River on US 99E at Marysville was nearly completed.

On the north state portion of US 99 projects were completed, under construction, or budgeted to provide 30 miles of continuous freeway and expressway in the Sacramento River Canyon from north of Shasta Lake to north of Dunsmuir. Another big project was under way north of Weed.

The projects listed are by no means all of the large-scale freeway and expressway jobs completed or in progress during the past year. There were also major reconstruction and realignment projects on major highways in rural and scenic areas, plus minor improvements and spot corrections on all types of state highways.

Freeway Safety Research

California's freeways for many years have had a better safety record than all the other types of highways in the state.

For the past five years, the fatality rate on freeways has been about one-third the rate on conventional rural highways, and the overall accident rate has been about one-half the conventional highway rate (see accompanying chart).

On top of this, freeways are tremendously efficient. In many instances, the daily traffic loads now carried by freeways could not be handled by any other type of street or highway. Sections of freeway in Los Angeles, for example, are now carrying an average of about 200,000 motor vehicles a day.

Because of the time-tested safety and efficiency of freeways, possible revisions in design must be approached with deliberate caution. A hasty change might do more harm than good.

Whenever a possible design revision is proposed—especially one related to safety factors—the division considers it in close detail, applying careful statistical and scientific methods in combination with long years of practical engineering experience.

One such design change which has been under study for several years is the possible use of some type of barrier in the center strip on freeways. This has often been proposed as a means of reducing cross-median head-on collisions. (This type of accident happens much less frequently on freeways than most people realize, but when it does it is often spectacular as well as tragic.)

In 1959 the division completed an extensive two-phase study of the median barrier problem, gathering data to supplement somewhat inconclusive studies of the past.

The extensive median barrier research project included a series of laboratory-controlled crash tests and a statistical and engineering analysis of a large number of accidents which occurred over a period of years on various types of divided highways.

The crash tests were conducted by the division's materials and research department. Fifteen different barrier designs were tested.

Passenger cars, and even a large bus, were smashed against a variety of barriers at speeds up to 60 miles an hour. The cars carried an instrument-equipped dummy. Special cameras and testing apparatus also recorded results.

Seattle Public Library
FEB 29 1960



Federal aid secondary county rood six miles north of Callohon in Siskiyou County.



Extension of Central Freewoy in San Francisco to Golden Gate Avenue near Civic Center.



New freeway alignment of Redwood Highway (US 101) with prizewinning bridge over Eel River. Old bridge at left retained for access to redwood groves and parks.



US 101 converted to full freeway through Arroyo Grande in San Luis Obispo County.



Modernization of section of Black Point Cutoff in Marin County and completion of the new Petaluma Creek bridge.



Considerable progress made on conversion of Grapevine Grade, US 99 in Kern County, to eight-lane freeway.

IN 1959 many hundreds of miles of the California state highway system were realigned and modernized. Some of these were great urban freeways, others were recreation routes or farm to market roads in rural and mountain areas. These photos show a representative selection of these jobs.

Below: Resurfacing and flood damage repair on State Sign Route 140, the Merced Canyon route into Yosemite.



Five freeway sections on US 40 were completed between Sacramento and Nevada state line in 1959, including this portion east of Donner Lake.



Harbor-Santa Monica Freeway Interchange bridges completed prior to construction of Santa Monica Freeway, to facilitate later contracts.



Object of the tests was to find the types of barriers which would come closest to meeting three exacting requirements:

1. Prevent out-of-control vehicles from crossing the center strip;
2. Reduce the chances of deflection back into the traffic stream;
3. Absorb high-speed impact so as to reduce the threat of injuries to passengers in the car striking the barrier.

The tests showed two barrier designs to be the most satisfactory.

One is made up of chain link fence and three three-quarter inch steel cables. The cables are strung along the fence, two about 30 inches above the ground and the third near the bottom of the fence.

The other design, judged suitable for narrower medians, consists of back-to-back steel guard rails attached to wooden blocks and posts. There is also a supplemental lower rail to the posts. The wooden blocking and prevent vehicles from hooking into posts and the lower rail, it was found, tend to reduce the severity of collisions with the barrier.

The detailed accident study conducted by the traffic department included a careful analysis of 8,000 accidents which occurred on 265 miles of various types of divided highways in 1956 and 1957, plus a review of all fatal freeway crashes in 1956 through 1958.

This study showed that where traffic volumes were not extremely heavy, highways with barriers had higher accident and injury rates than those without barriers.

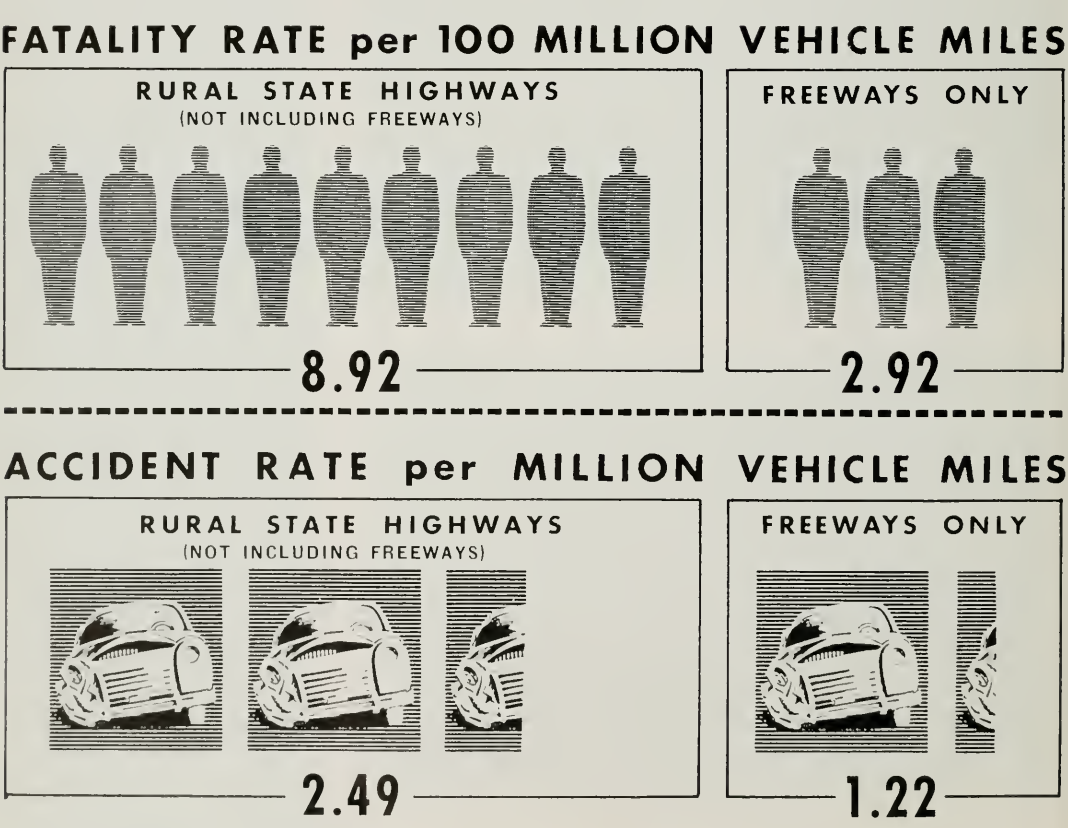
On the other hand, where traffic was very heavy, highways with barriers appeared to have lower accident rates.

As a result of the impact test and accident studies, the new types of barriers are now being installed on some sections of heavily traveled freeway in the Los Angeles and San Francisco Bay regions.

If the new barriers prove to be effective under actual operating conditions, they will be installed on other heavily traveled routes, and at problem locations, in an effort to further improve the already favorable safety record of freeways.

Highway Financing

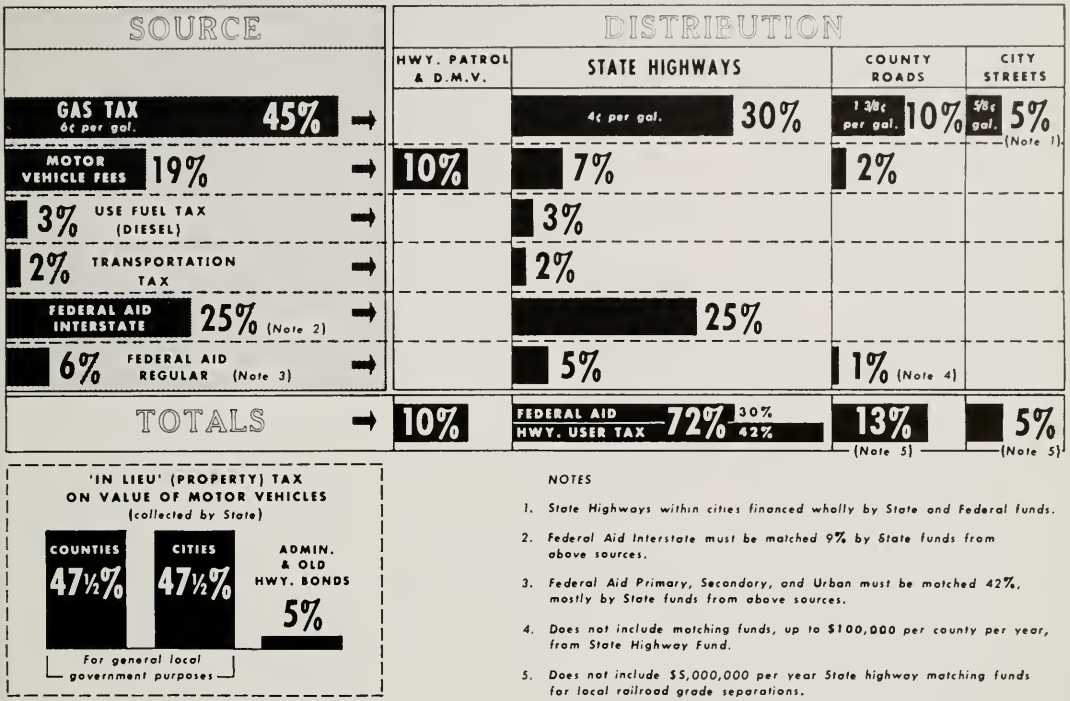
The 1959-60 State Highway Budget contained a total of $497,000,000 for state highway construction and rights-of-way. As adopted by the Highway Commission in October 1959, the



Highway User Taxes Including Federal Aid

Percentages based generally on 1960-61 Budget.

State of California
Department of Public Works
Division of Highways



NOTES

1. *State Highways within cities financed wholly by State and Federal funds.*
2. *Federal Aid Interstate must be matched 9% by State funds from above sources.*
3. *Federal Aid Primary, Secondary, and Urban must be matched 42%, mostly by State funds from above sources.*
4. *Does not include matching funds, up to $100,000 per county per year, from State Highway Fund.*
5. *Does not include $5,000,000 per year State highway matching funds for local railroad grade separations.*

1960-61 Budget provides $452,800,000 for these purposes.

The cutback in federal financing, which was only partly offset by increases in revenue from state sources, is reflected in these comparative construction budget totals for the two fiscal years.

The backbone of California's highway financing structure is the state gasoline tax of 6 cents a gallon. Four cents is applied to state highways, 1⅜ cents goes for county roads, and ⅝ of a cent for city streets other than state highways.

In addition to the gasoline tax, other sources of highway revenue in California are use (diesel) fuel taxes, transportation taxes, and motor vehicle, registration, and weight fees. (Revenue sources and distribution for road purposes are indicated in the accompanying chart.)

A substantial amount of the money for state highways, from the State's 4-cent share of the gas tax, is also used each year to help pay for local city and county projects not on state highways.

For example, state highway funds are made available each year to match federal allocations for county roads, to help pay the cost of city and county railroad grade separation projects, and for city street engineering and administration.

In the 1959-60 fiscal year, state highway funds allocated for these three purposes alone amounted to more than $10,000,000. This money supplements and in effect increases the regular share of the gas tax revenue received by the cities and counties.

According to law, 55 percent of the money available each year for state highway construction, including rights-of-way, is allocated to the 13 southern counties. The remaining 45 percent goes to the northern 45-county group. Each county is guaranteed a minimum share of the construction funds in a specified period of years. Federal highway funds must be applied to routes included in the various federal aid systems of secondary, primary, urban, and interstate highways.

In preparing the annual state highway budget, the Highway Commission must review hundreds of high-priority projects and attempt to choose those which will meet the most acute local and regional needs, comply with federal financing requirements, and at the same time fit logically into the long-range program for highway development on a statewide basis.

Thorough study and comparison of all available data, including compre-

hensive information on traffic volumes, accidents, population changes, road conditions, and other factors, is required.

Highway construction in California is expedited by a particularly helpful provision of state law which permits the award of construction contracts for highway projects as early as January 1, six months before the start of the fiscal year in which the project is budgeted. Last year 112 contracts were awarded before the start of the 1959-60 fiscal year, thereby allowing a longer construction season and advancing the completion date on many projects.

Planning

The Division of Highways prepares plans and estimates on highway projects well in advance of the time when construction is actually expected to start.

This policy of long-range planning enables the Highway Commission to use all revenues as soon as they become available, thanks to a backlog of projects ready to advertise for bids.

The value of this planning program was demonstrated last year when California successfully completed $29,500,000 in construction on state highways with additional unanticipated funds provided under the anti-recession provisions of the 1958 Federal Highway Act.

California received the federal apportionment for this "crash" program in April 1958. Projects financed with the added funds had to be under contract by December 1958, with provision for completion by December 1959.

Under the special federal program, 23 state highway projects, including several multimillion-dollar freeway jobs, were opened to traffic by the December, 1959, deadline. (Additional projects were completed on county roads, as described later in this report.)

The successful completion of the crash program, undertaken on short notice with specified deadlines was possible only because of sound practices of continuing advance planning. Plans and specifications were ready and the right-of-way had been acquired, making it possible to apply the added federal funds to construction projects without delay.

Such rapid utilization of funds means savings in fuel and upkeep expense to motorists who enjoy earlier use of improved highways. More important, it has resulted in earlier elimination of outmoded or congested highway sections, many with high accident rates.

Freeway Route Selection

Essential to the advance planning program of the Division of Highways is the early determination of freeway routes by the Highway Commission.

Before detailed design studies for any freeway project can proceed, of course, the location of the route must be decided upon. Early determination of freeway routes also helps local city and regional planners by fixing permanently one of the major transportation factors of the area.

In California, freeway routes are selected according to policies and procedures which have been established over the years by the commission and the highway division.

Object of these procedures is to insure painstaking study, thorough consideration of all data, and complete public discussion of each possible route.

Briefly, the freeway route selection process is as follows:

General termini for state highways are named by the Legislature. Before possible alternate freeway routes between these termini are even in mind, the Division of Highways gets together with city or county planners and traffic engineers to determine the area's highway needs and general plans. Local government agencies are notified that route studies are commencing. Informal public meetings are often held to explain problems involved and to obtain preliminary ideas.

Working in close co-operation with local technical staffs, the division conducts extensive traffic, engineering and economic studies. All local master plan information is carefully reviewed.

These studies provide the facts necessary for the projection and evaluation of the various alternate routes which might be considered.

Some alternates will be undesirable because they would adversely affect such "controls" as schools, hospitals, cemeteries, important landmarks, or recreational facilities.

Others will be unfeasible for engineering reasons or because they would require too much of the taxpayers' money for the benefits they would provide. Still others will be unsatisfactory because they would provide inadequate traffic service.

Finally, after several years of study and restudy, the division boils down the possibilities to what are considered to be the most suitable choices from the standpoint of traffic service, effect on the community, economic influence, construction costs, and right-of-way costs.

These alternate routes are then subject to intense public review at a series of meetings, both formal and informal, conducted by the Division of Highways. Last year the division held 55 official public meetings on freeway route matters, plus several hundred informal meetings and map displays.

Often these public discussions reveal a course for further investigation. Upon completion of these additional studies, the State Highway Engineer recommends to the Highway Commission the route which appears to offer the best combination of traffic service and community or area benefits. Information on all other routes is also provided to the commission.

The Highway Commission will then take the matter of a routing under consideration.

In particularly difficult cases, the commissioners will decide to get first-hand information from local citizens by calling a public hearing in the area concerned.

In every case, local governing agencies will be notified that if it is considered necessary or desirable, the Highway Commission will hold a public hearing on the matter. Last year the commission held five public hearings in local areas.

Even when no hearing in requested, the commission will announce its intention to adopt a route and withhold action for at least 30 days to allow time for submission of additional data and proposals.

All supplementary information presented at the public hearings, along with the data developed during the comprehensive studies and public

meetings conducted by the highway division, are carefully considered in the commission's deliberations.

Most of these route decisions are extremely difficult, especially in built-up areas. Nearly any route which the commission might select will be unsatisfactory to some individuals, even though this route is the one which offers the best service and the most benefits to the greatest number.

At the end of 1959, there were 5,100 miles of adopted freeway routes in California. This large total is particularly significant as the State embarks on the 20-year freeway-expressway system plan. It means that a great amount of the preliminary spadework has already been completed with routes selected for about 40 percent of the master plan highway mileage.

Landscaping and Planting

California's highways are the scene of an increasing number of planting and landscaping projects. The last three annual budgets adopted by the Highway Commission have provided an aggregate of approximately $12,000,000 for such projects.

Freeway landscaping and planting projects are carefully worked out by the division's staff of landscape architects to serve functional as well as beautification purposes.

Planting of selected trees, shrubs, and plants not only enhances the appearance of a section of freeway, it also meets functional needs such as the screening of headlight glare and noise and the prevention of erosion damage.

Care and control of roadside landscaping and other vegetation is a big and costly job requiring the services of hundreds of landscaping specialists and tree workers.

The division also carries out weed and fire hazard control programs designed to provide protection for agricultural and forest lands bordering state highways. These programs are often conducted in co-operation with other agencies.

Highway Maintenance

Mild weather and light snowfall eased the problems of the division's maintenance crews in 1959. Storm damage to highways was small when compared to previous years, although there were some severe local problems.

Periods of warm weather permitted intermittent openings of such roads as the Deer Creek Highway (Sign Route 32) and the Angeles Crest Highway (Sign Route 2) which are usually closed during the winter.

All of the major mountain pass highways which are closed each year by snow were reopened at the earliest dates in history. The last to be reopened, Tioga Pass on State Sign Route 120, was back in service May 13, 10 days ahead of the previous earliest date.

The maintenance of the State's highways is an important and continuing part of the work of the division. California's varied climate and topography dictate a broad maintenance program requiring equipment and personnel for a wide range of tasks.

In addition to such annual duties as snow removal and repairs after winter storms, the maintenance department is also responsible for such jobs as the care of roadside trees and landscaping, the posting of warning and directional signs, bridge repair, adjustment of electronic traffic signals, and a constant program of resurfacing, patching, sealing, painting, spraying, and shoulder maintenance.

George T. McCoy, California State Highway Engineer for 16 years, retired October 1, 1959.

After serving with the Washington State Highway Department, McCoy moved to California in 1927 as an assistance office engineer for the Division of Highways.

He was appointed administrative assistant to the State Highway Engineer the following year. In 1933 he was advanced to the position of Assistant State Highway Engineer, becoming State Highway Engineer in 1943.

McCoy was succeeded by J. W. Vickrey, who died unexpectedly on December 4, 1959.

Vickrey had served with the Division of Highways for 42 years. He was named Assistant State Highway Engineer—Planning in 1947 and Deputy State Highway Engineer—Engineering in 1955.

No small job for maintenance crews is the picking up after highway litterbugs. Cleanup work by state forces last year cost more than $600,000.

In an effort to curb this continuing expense, the division maintains hundreds of litter disposal cans along highways throughout the State. Signs indicating the locations of litter cans have also been installed.

To better co-ordinate its broad, statewide activities and to obtain up-to-the-minute reports of road conditions, the maintenance department has developed a radio network which includes 175 radio stations, 23 microwave stations, and 900 mobile radio units.

During the winter, accurate road condition reports are received by radio from the field and supplied to newspapers, automobile clubs, radio and television stations, and other interested agencies through division-operated teletype facilities.

Equipment

The operation and maintenance of California's highways requires a great deal of automotive and maintenance equipment including various trucks, automobiles, graders, snowplows, power shovels, tractors, and miscellaneous items such as rollers, mixers, trailers, hoists, pumps, drills, and mowers.

The division's automotive and maintenance equipment inventory at the end of the 1958-59 fiscal year was $25,700,000.

The Equipment Department carries out a program of continuing research aimed at finding better, more efficient equipment to reduce operating costs. Many new pieces of equipment are designed, assembled, modified, or constructed in the department shops to meet special highway uses.

Among the recently designed or developed equipment items are a new paint striping machine which eliminates the sulky that was formerly pushed in front of the striping truck. New power ladders and improved cranes have also been developed.

During the 1958-59 fiscal year, the division acquired 990 new equipment units with a total value of $4,600,000. Most of these units replaced obsolete or worn out equipment.

Materials and Research

The median barrier crash tests described earlier in this report were conducted by the staff of the division's Materials and Research Department.

The department's extensive laboratory in Sacramento, one of the largest of its kind, is headquarters for a statewide research and testing organization which includes specialized branch laboratories in Los Angeles, Bakersfield, Santa Maria, and Berkeley. The department also co-ordinates the technical work of laboratories in each of the 11 state highway districts.

The work of the Materials and Research Department may be classfied in two main categories—testing to make sure the State gets its money's worth from every highway construction dollar, and research to develop better methods and materials.

Although the median barrier tests were probably the most spectacular of the department's recent research projects, there have been several other important areas of investigation.

A practical means of obtaining better nighttime visibility for traffic stripes, especially during rainy weather, has been under study for some time. An improved reflective plastic button has been developed and is now being tried on a section of highway in San Francisco in an effort to solve this problem.

Inexpensive machines to test the smoothness of pavement have been introduced, making it possible to measure and correct rough spots while construction is in progress.

From experience gained in construction of the parallel Carquinez Bridge at Crockett, new methods have been devised for controlling certain types of welds in alloy steel.

The sonics laboratory has conducted several investigations of freeway traffic noise. In general, these studies have shown that most freeways cause less disturbance than ordinary city streets with posted or signalized intersections where traffic moves on a stop-and-go basis.

New Speed Limit

On January 1, 1960, the maximum speed limit for automobiles on California highways was changed to 65 miles an hour as a result of legislation enacted by the 1959 Legislature. A prima facie limit of 55 miles an hour formerly applied, making it permissible to travel at faster speeds under favorable conditions.

Preparations for the new maximum speed limit occupied much of the time of the division's traffic engineers during the last few months of 1959.

From the standpoint of traffic engineering and safety requirements, the new speed limit involved much more than putting up maximum speed limit signs.

There are many sections of highway, especially in and near built-up areas, where the 65-mile limit is too fast for prevailing conditions. About 200 miles of this type of highway were rezoned for slower speeds by the end of 1959. Many of them are now posted as 55-mile zones.

At all highway entrances to California, large signs were installed to warn that the maximum speed limit for autos is 65 miles an hour, all trailers 45 miles an hour, and trucks 45 miles an hour. California's basic speed law, which requires drivers to adjust speeds to conditions, also remains on the books.

Restricted speed zones in California are established by the Department of Public Works on the basis of engineering and traffic studies conducted by the Division of Highways. Enforcement of speed limits is a duty of the California Highway Patrol and local authorities.

Bridges

The Division of Highways Bridge Department, with its own design and construction staff, is responsible for all structures on state highways.

These include elevated freeways, traffic interchanges, overcrossings, undercrossings, highway-railroad separations, underwater tubes, and bridges over rivers, streams, and other bodies of water.

The bridge department also supervises the operation and maintenance of the state-owned toll bridges—the San Francisco-Oakland Bay Bridge, Richmond-San Rafael Bridge, San Mateo-Hayward Bridge, Dumbarton Bridge, and the Carquinez Bridge.

Toll collections began on the Carquinez Bridge on US 40 in November 1958, after completion of the new parallel structure over the Carquinez Strait. Improvements to the old bridge were completed in April 1959.

In its first year of operation as a toll facility, the Carquinez Bridge served more traffic and earned more money than any of the advance estimates had indicated.

In fact, first year revenues of $4,255,075 were higher than the estimated revenues for both the Carquinez and the Benicia-Martinez Bridges for the year 1964. The two bridges are financed by Toll Bridge Authority revenue bonds.

Work started on the Benicia-Martinez Bridge in mid-1959 and completion is expected in late 1962. Two contracts totaling $14,765,000 were awarded for the bridge proper. The toll project will also include freeway approaches in both Contra Costa and Solano Counties.

Located about 200 feet downstream from the existing railroad bridge across the strait, the highway bridge will replace the present division-operated ferry service. It will be of deck-truss type construction with a total length of 6,215 feet and an overwater length of 4,880 feet. The bridge deck will be 187 feet above water at the highest point and 62 feet wide between curbs, providing a four-lane highway with a 10-foot dividing strip.

A method for financing the long-discussed San Pedro-Terminal Island Bridge was decided upon last year, after some 10 years of deliberation and planning. Construction is expected to start in 1960.

This 6,010-foot bridge over the Main Channel of the Los Angeles Harbor will cost an estimated $20,000,000. Financing will be from revenue bonds not to exceed $6,000,000, from State Highway Funds, and from State Highway User Tax Funds available to Los Angeles County and to the City of Los Angeles.

Another long-planned and extensive project got under way last year when work started on the Webster Street Tube, a second underwater tube between Oakland and Alameda. The Webster Street Tube will be about a block west of the present Posey Tube under the Oakland Estuary. The new tube will be made up of 200-foot seg-



Bridges and freeway structures designed by the Division of Highways Bridge Department have been singled out for a number of awards in recent years. Last year this structure across the South Fork of the Eel River on US 101 (Redwood Highway) in Humboldt County was included among bridges judged most beautiful in national competition sponsored by the American Institute of Steel Construction.

ments, prefabricated in drydock, floated to the proper location, and lowered into a prepared trench. The project is expected to be completed around the end of 1962.

Largest of the state-operated toll bridges is the San Francisco-Oakland Bay Bridge, which carried a total of 37,215,818 vehicles during the 1958-59 fiscal year, a gain of 5.6 percent over the preceding year.

Under California law, $5,000,000 is set aside each year in the State Highway Budget to help finance local railroad grade separation projects included on a priority list established annually by the State Public Utilities Commission. These local projects are not on state highways.

The cost of such projects, after deduction of any contribution by the railroad involved, is shared equally by the local agency and the state.

During 1959, the Highway Commission made allocations from the special fund to help pay for local railroad grade separation projects on White Avenue in Pomona, on Beale Avenue in Bakersfield, on Mount Vernon Avenue east of Bakersfield, on 24th Street in Paso Robles, on De La Cruz Boulevard in Santa Clara, on Sutterville Road in Sacramento, and on Center and El Dorado Streets in Stockton.

Right-of-way

A total of 7,785 right-of-way transactions were concluded in the 1958-59 fiscal year. Of these, more than 98 percent were negotiated settlements with property owners. Less than 2 percent were concluded through contested court proceedings.

One big reason for the large number of amicable right-of-way transactions is the State's policy of paying fair market value for required property. In dealings with right-of-way personnel, owners can expect to receive the same amount for their holdings as they would from any other buyer under normal market conditions.

The methods and policies of the Right-of-way Department are outlined in the booklet, "More Than 15 Million People Want My Property," which is mailed to affected property owners before their property is appraised (copies available on request).

Acquisition of rights-of-way in California is expedited in some cases by a special fund which has been authorized by the Legislature.

This $30,000,000 revolving fund has been set up to cover the advance purchase of rights-of-way on which costly improvements are slated. Expenditures from the fund are repaid from regular highway revenue when the construction period is reached for each project.

The effect of this procedure is to provide funds to purchase property before improvements are made, even though actual highway construction may be some years in the future.

During the 1958-59 fiscal year, money from the revolving fund was used to acquire 49 parcels of land—resulting in an estimated savings of $9,320,000.

County Roads

Out of 69,000 miles of county roads in California, approximately 7,500 miles are included in the federal aid secondary system. For the most part these roads are next in importance to state highways in terms of traffic volume and economic service. They are often referred to as "feeder roads" or "farm to market roads."

Projects on these federal aid secondary routes are planned and in most instances constructed under the direct supervision of the county involved. The Division of Highways, under federal regulations, has the responsibility for reviewing and approving these county projects. The division also assists in other phases when requested to do so by the counties.

Working in close co-operation with the division, California's counties compiled a commendable record in the planning and construction of FAS county roads during the past year.

This was particularly true in connection with the use of "crash program" funds made available under the antirecession provisions of the 1958 Federal Highway Act.

The participating counties undertook 67 county road projects with the special funds at a cost of approximately $6,500,000. All but one of the county road improvements were com-

pleted by the December 1959 federal deadline, and the time limit for the unfinished project was extended.

The regular 1959-60 federal apportionment to the counties for use in improving roads on the FAS system amounted to $8,724,389. State highway funds made available to the counties for use in matching this allocation totaled $4,273,060.

The largest source of revenue for all county road purposes is the 1⅜-cent share of the State's six cents a gallon gasoline tax. These funds are distributed directly to the counties by the State Controller, and are administered by local boards of supervisors.

Apportionments are made according to law on the basis of proportionate motor vehicle registration and mileages of county-maintained roads. For 1958-59 the counties received as their share of the gas tax, along with a portion of the vehicle registration fees, a total of $79,595,990.

City Streets

The Division of Highways administers the apportionment on a population basis of the five-eighths cent per gallon share of the gasoline tax which goes to incorporated cities and reviews and approves major city street improvements not on state highways which are financed with these funds.

In addition, the division apportions state highway funds set aside for city street engineering and administration purposes. According to law, this apportionment ranges from $1,000 a year for cities with a population of less than 5,000 to $20,000 for cities of more than 500,000 population.

During the 1958-59 fiscal year, a total of $31,562,053 was paid to the cities in gas tax money and engineering funds. This is an increase of $1,134,401 over the previous year. City street projects approved by the division during the fiscal year numbered 546. City street improvements during the period covered 212 miles.

Construction Contracts

California highway construction is performed under contracts awarded on the basis of competitive bidding. This insures that the public receives the greatest value for its highway construction dollar.

Contractors who desire to bid on state highway projects estimated to cost more than $15,000 are required to be prequalified by the division. Each contractor's financial capabilities, experience, and resources are studied in determining the type and size jobs he is qualified to undertake.

At the end of the 1958-59 fiscal year, there were 1,045 contractors with varying prequalification ratings, eligible for bidding on state highway projects. Total bidding capacity of these contractors was $2,115,000,000.

Of the 624 contracts awarded during the 1958-59 fiscal year, 79 percent were for projects costing less than $250,000. Thus, contractors with limited resources were capable of bidding on the great majority of state highway jobs.

About 12 percent of the contracts were in the $250,000 to $1,000,000 class, and approximately 9 percent went above the $1,000,000 mark.

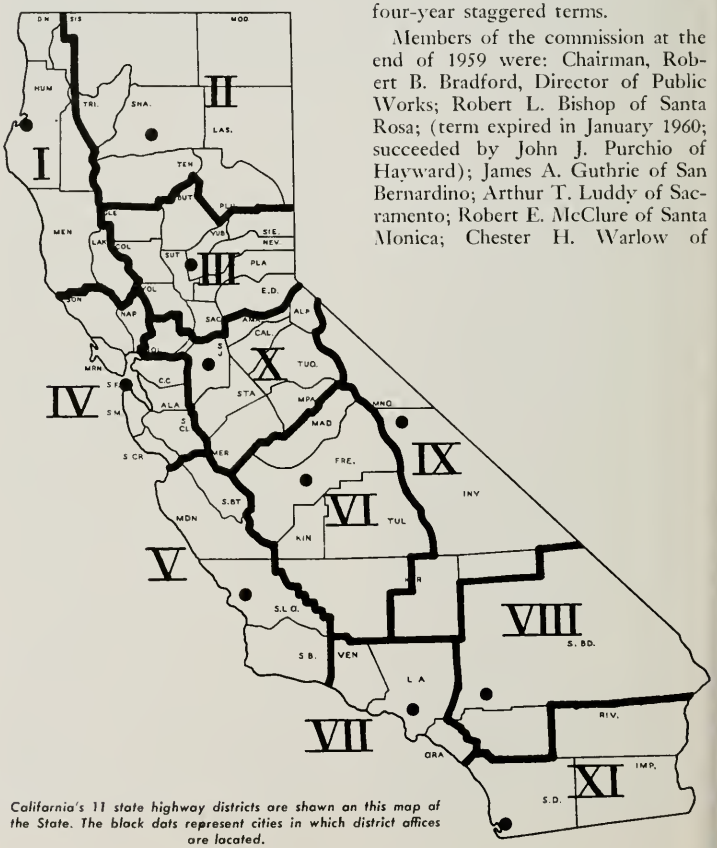
California Highway Commission

As noted earlier, responsibility for highway route adoptions rests not with the Division of Highways, but with the California Highway Commission, which is a nontechnical, nonsalaried board of business and professional men representing the people of the State at large.

Commissioners are appointed by the Governor, and the appointments are confirmed by the State Senate.

The commission is a seven-man body with the State Director of Public Works, as ex officio chairman, serving at the pleasure of the Governor. The other six members serve four-year staggered terms.

Members of the commission at the end of 1959 were: Chairman, Robert B. Bradford, Director of Public Works; Robert L. Bishop of Santa Rosa; (term expired in January 1960; succeeded by John J. Purchio of Hayward); James A. Guthrie of San Bernardino; Arthur T. Luddy of Sacramento; Robert E. McClure of Santa Monica; Chester H. Warlow of



California's 11 state highway districts are shown on this map of the State. The black dots represent cities in which district offices are located.

Fresno; and Roger S. Woolley of San Diego.

In addition to budgeting highway funds and adopting freeway and highway routes, the commission also approves county primary road systems and authorizes the execution of deeds, condemnation proceedings, and right-of-way abandonments and relinquishments.

Division Organization

Chief of the Division of Highways is the State Highway Engineer. He is assisted by a headquarters staff in Sacramento composed of two deputy state highway engineers, four assistant state highway engineers, a chief right-of-way agent, and a comptroller. Each of the assistant state highway engineers is in charge of a group of specialized units.

The State is divided into 11 state highway districts to provide for localized administration of the highway program (see map). These districts have approximately equivalent state highway mileage. A district engineer is in charge of each district except in the San Francisco and Los Angeles areas where an assistant state highway engineer is in charge.

The district engineer is responsible for all phases of the highway program in his district. Information concerning local highway matters is most readily obtained at his office.

District offices are in these cities:

District I
Eureka
430 West Wabash Avenue
Sam Helwer, District Engineer

District II
Redding
1657 Riverside Drive
H. S. Miles, District Engineer

District III
Marysville
703 B Street
Alan S. Hart, District Engineer

District IV
San Francisco
150 Oak Street
J. P. Sinclair, Assisrant Srate Highway Engineer

District V
San Luis Obispo
50 Higuera Street
A. M. Nash, District Engineer

District VI
Fresno
1352 West Olive Avenue
W. L. Welch, District Engineer

District VII
Los Angeles
120 South Spring Street
E. T. Telford, Assistant State Highway Engineer

District VIII
San Bernardino
247 Third Street
C. V. Kane, District Engineer

District IX
Bishop
South Main Street
E. R. Foley, District Engineer

District X
Stockton
1976 East Charter Way
J. G. Meyer, District Engineer

District XI
San Diego
4075 Taylor Streer
J. Dekema, District Engineer

Magazine Marks A.R.W.A. Anniversary

Organized in 1934, the American Right of Way Association observed its 25th anniversary with the December 1959 issue of *Right of Way*, official organ of the association published in Los Angeles as a bimonthly by the board of directors.

The lead article of this issue is the first of three installments on the history of the association, of interest to the right of way fraternity and the general public as well.

Also of interest is the Roll of Honor —charter members of Mother Chapter, Los Angeles 1—1934. Of the 81 charter members, 22 are still in the association and seven of the 22 are with the State Department of Public Works.

Heading the roll is the name of Frank C. Balfour, Chief Right of Way Agent of the State Division of Highways, recognized as the founder of the association and its national chairman from 1945 to 1956.

Balfour joined the staff of the division in the Right of Way Department in January 1931. After brief experience in the field, he quickly recognized the need for sound real estate valuation procedures and training courses for right of way men.

With the advice and encouragement of Spencer V. Cortelyou, then Division of Highways District Engineer in Los Angeles, Balfour enlisted the support of 14 able Los Angeles right of way men, who met October 16, 1934, to hold the first organization meeting of the Southern California Right of Way Agents' Association. In one year the membership of the association more than doubled. Now, with some 7,000 members in the United States and Canada, the organization has 30 chapters and three club affiliates from coast to coast and in Hawaii.

A reproduction of the first issue of *Right of Way*, a modest four-page sheet dated March 20, 1935, monthly bulletin of the Southern California Right of Way Agents' Association and forerunner of *Right of Way*, is tucked into the 25th Anniversary Number.

The seriousness of right of way problems was recognized by the California Highway Commission very early in the beginning of highway development in California. In the May 1, 1913, *California Highway Bulletin* (predecessor of *California Highways and Public Works)* is an article by C. C. Carleton, attorney (retired in 1949 after many years as Chief of the Division of Contracts and Rights of Way of the State Department of Public Works), titled "Securing Rights of Way for the State Roads," in which is written, "The commission, however, has from the beginning realized the importance of acquiring rights of way promptly and systematically." The right of way men know better than anyone how much the problem has been augmented by the fantastic growth of population in California.

The ultimate objective of the association as stated in its anniversary issue: The establishment of a specific major course of study on right of way and land acquisition in colleges and universities.

Plans are being prepared for the acquisition of rights-of-way and start of widening on the San Mateo-Hayward Bridge.

Hayward Attorney is Named to Commission

John J. Purchio of Hayward, widely known attorney, and civic leader, became a member of the California Highway Commission on January 15. He was appointed to the post for a four-year term by Governor Edmund G. Brown upon the expiration of the



John J. Purchio

term of Robert L. Bishop of Santa Rosa, who had served on the commission since January 1956.

Born in New York 45 years ago, Purchio was graduated from Fordham College and Fordham University Law School, served with the U.S. Air Force in Europe as an intelligence officer, and has been engaged in the practice of law in Hayward since 1947.

He has long been active in civic affairs and politics, serving on the city council of Hayward since 1953, including one term as the city's mayor. He resigned from the city council upon his appointment to the Highway Commission.

In connection with his city council activities he has been actively concerned with highway developments in Hayward and other sections of Alameda County as his city's representative on highway committees.

Purchio was recently appointed by Governor Brown to the advisory committee which is assisting the Golden Gate Authority Commission.

He has also been active in the State Bar of California, currently serving on its legislative committee, and was Resolutions Chairman of the 1959 Conference of the League of California Cities.

Purchio is married and has six children. He lives at 2375 Lancaster Court in Hayward.

Latest Cost Index Shows Down Trend

During the fourth quarter of 1959 the California Construction Cost Index continued in a downward course. The index now stands at 229.1, a drop of 31.2 points or 12.0 percent from the third quarter of 1959.

The continued drop is apparently due to extremely strong competition on a number of large attractive projects. The slowdown in highway construction during 1959, due to uncertainty over federal legislation and the depletion of the Highway Trust Fund, served to increase competition over projects on which bids were opened during the last quarter. Reports from other states, and other indexes reviewed below, indicate that the drop is largely confined to California.

The Engineering News-Record Cost Index for the fourth quarter of 1959, which now stands at 334.7, shows a slight decrease under the preceding quarter. It is down 0.1 index point or 0.03 percent. This index is strongly affected by many large projects outside the highway construction field. It is the first decrease since 1949.

The Bureau of Public Roads Composite Mile Index is based on federal-aid highway construction contracts awarded by the state highway departments. The index for the third quarter of 1959 increased 0.5 index point or 0.2 percent from the second quarter of 1959 and now stands at 228.3. However, it is 1.4 percent lower than that for the third quarter of 1958. According to the Bureau of Public Roads, the small fluctuations of the past several years appear to indicate continuance of a trend of stabilization in prices.

John Stanford Named Assistant Director

Appointment of John H. Stanford as Assistant Director of the State Department of Public Works has been announced by Director Robert B. Bradford.

Stanford, a career management worker in state service since 1946, is a



John Stanford

native of Urbana, Illinois, and a graduate of the University of California. He received a master's degree in public administration at Syracuse University, and served as a captain in the Air Force during World War II.

He entered state service with the Department of Finance, later transferred to the Department of Insurance as administrative service officer, and returned to the Department of Finance in 1952 as a senior management analyst. He moved to the Department of Public Works as its supervising management analyst in 1956.

Stanford is a past president of the Sacramento chapter of the American Society for Public Administration and the American Records Management Association, and a member of the Western Governmental Research Association.

He is married and has three children. His home is at 5417 Spilman Avenue, Sacramento.

The State Legislature has added a section to the Vehicle Code permitting the use of approved snow-tread tires in place of tire chains.

Profilograph—1

Devices for Recording Road Roughness Described

By FRANCIS N. HVEEM, Materials and Research Engineer

EVER since roads and highways have been constructed, the people who use them have been keenly aware of the relative degrees of comfort or discomfort experienced in traveling. This awareness has been so deeply ingrained that most languages contain metaphors such as "rough road" or "smooth road" as descriptive of many human experiences involving hardship or good fortune.

This article is the first of two describing the development of use of devices for measuring the roughness of pavement. This material was also presented before the Highway Research Board at its 39th Annual Meeting in Washington, D.C., January 11 to 15.

There is no doubt that mankind has long thought of road smoothness or roughness as being synonymous with pleasant or unpleasant. Road surface roughness is not easily described or defined and the effects of a given degree of roughness naturally vary considerably with the speed and characteristics of the vehicle. Anyone looking at photographs of Roman roads (Figure 1) must wonder how it felt to ride in a chariot over such surfaces, especially as the chariots had steel or bronze tires and no springs. One might assume that the repair bills on chariots were fairly high, and undoubtedly the occupants had real cause to feel "shook up."



Figure 1. A street in Pompeii showing stepping stones and grooves worn by chariot wheels.

Little Progress at First

As we move into more modern times, references to roads appear in the folk lore, both in song and story and in the literature. We have the wistful song about the high and low roads that lead into Scotland, but roads were little, if any, smoother a hundred years ago than they were in the times of the Romans, and our hardy ancestors were not above complaining about them. The "rocky road to Dublin" is legendary, and it may be that the Irish were more concerned over such things than most because it appears that an Irishman may have been the first man to construct a device for measuring road roughness, at least the earliest reference thus far found is in a book entitled "Road

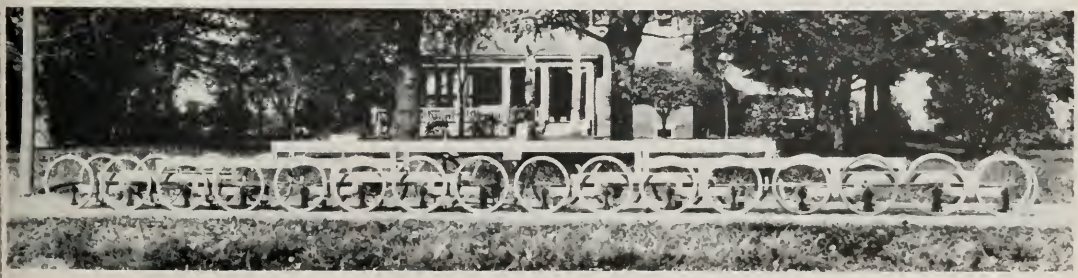


Figure 2. A profilograph constructed by the State of Illinois for the Bates road test, circa 1922.

Making and Maintenance" by Thomas Aitken. This book was published in 1900 and on page 420 there is a discussion of an instrument called the "Viagraph." It is said to be the invention of Mr. J. Brown, an engineer of Belfast, Ireland, and is described as being "a straight-edge, 12 feet long and 9 inches wide, applied continuously to the road surface, along which it is drawn."

This early Viagraph contained "an apparatus for recording on paper a profile of the road surface tested, and the sum of unevenness is indicated by a numerical index." I am mildly chagrined to note this description as I "invented" a device employing the same principle in 1929. Mr. Brown goes on to discuss the gravel and macadam-type road surfaces that were characteristic of his time (in the years prior to 1900) and concludes that steamrollers offer a distinct advantage in effecting a regular and smooth surface. He shows some "autograph records" of macadamized road surfaces and states that, "In the author's opinion, after experience gained in working this instrument over many miles of road and under varying circumstances, a standard of fitness or smoothness of 15 feet of unevenness, or variation from a regular plane, per mile of road might be safely adopted." Mr. Brown's device furnished virtually all the information obtainable from the most modern profilograph units today—except that he measured "roughness" in feet instead of inches per mile.

Accurate Measurement Needed

With the high speeds common to modern vehicles on highways and airplanes on landing fields, even minute deviations in the pavement surface become a matter for concern. In the last 40 years there have been many



Figure 3. The Bureau of Public Roads Pavement Roughness Indicator, outrigger trailer and tow car.

devices developed for measuring, evaluating or locating the individual high and low spots on a pavement surface. Following Mr. Brown's Viagraph, no record has come to light of similar devices until we come to the era of the Bates road test in Illinois in 1922. Mr. A. C. Benkelman kindly furnished photographs of a Profilometer built by the State of Illinois at that time (Figure 2). Judging from the photograph, this was a most impressive instrument in which the frame was supported by 32 bicycle wheels mounted in tandem. According to reports, this particular model was not too successful and undoubtedly was unwieldy and difficult to handle. It does, however, represent a most elaborate example of the principle which is still being used; namely, a series of wheels mounted on short beams or "eveners" to produce a mechanical integration; that is, the center point of the main frame parallels in elevation at all times a point representing a mean elevation between the high and low spots of the pavement contacted by the series of wheels. By this means, a datum plane is produced to serve as a "plane of reference" for the recording wheel that follows the actual profile of the pavement. All of the straightedge types of which Mr. Brown's pioneer model is an example measure the profile in terms of depth below the peaks or high points on the road surface within the length of the straightedge.

Profiles Recorded

With the rapid expansion of the motor vehicle and increasing awareness of riding qualities, another type made its appearance. One of the earliest was the "Via-Log" developed in the State of New York. The Via-Log consisted of means for recording a profile on a strip of paper, the stylus being actuated by the vertical movements of the front axle of an automobile with reference to the frame of the car. In order to produce a reading, the car had to proceed at appreciable speed, say 20 miles per hour or more.

Public Roads magazine for September 1926 reports on a variant of this instrument for the measurement of relative road roughness. It is described as consisting of a "rack which is attached in a vertical position to the front axle of the vehicle, Fig. 31. Meshed with this rack is a spur gear which is supported by the frame of the car. Movement of the front axle with respect to the chassis, caused by deflection of the body spring, thus produces translation of the rack and rotation of the gear. This gear is connected through a flexible shaft to a mechanical counter on the instrument

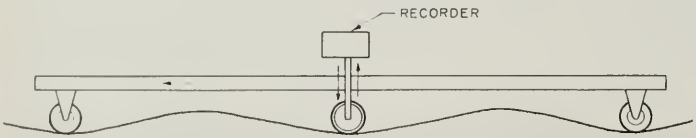


Figure 4. The above diagram illustrates the potential error produced by a device equipped with only three points of contact. The wave pattern corresponds to the spacing of the wheels and the profilograph record will be a strait line.

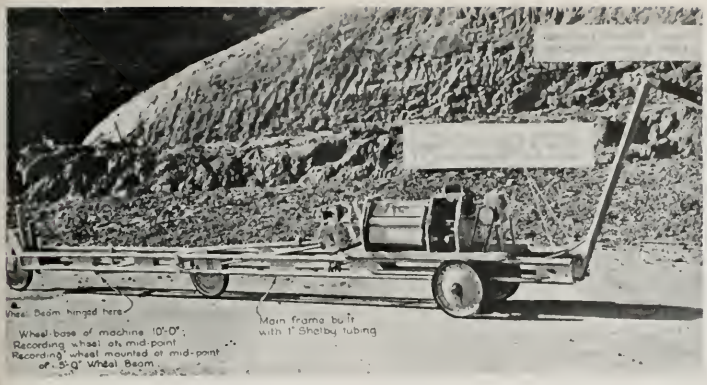


Figure 5. A viagroph designed by the Los Angeles Road Department.

board of the automobile." Modifications and developments of this type have been used for many years in California and by other states and agencies. Constant difficulty was encountered in securing uniformly reproducible readings and results obtained with the same apparatus mounted on different automobiles gave widely different results.

Trailer Unit Developed

The Bureau of Public Roads continued to work on the problem and in *Public Roads* for February 1941 reported on a trailer unit (Figure 3). In principle, this device is similar to those mounted on an automobile except that carefully selected springs, means for dampening and the weight of the unit can be standardized and thus produce an instrument that is not subject to variations such as exist between automobiles of different size and make. This road roughness indicator is probably the one most widely used in recent years, having been duplicated by several states and other agencies. Figure 9 shows traces of the record produced by one of these units operated by Professor R. A. Moyer of the University of California. However, it is subject to the same criticism as applies to recording devices actuated by the front axle of a car. One might quote from an article on "Independent Wheel Suspension" by Maurice Olley, Special Problems Engineer, Cadillac Motor Car Company, "Frequently analysis of a car on the road shows that the average road at normal speeds disturbs the passage of the car by acting as an excitation for the natural frequencies of the car itself. The motion of the car, in other words, is never a true picture of the road surface but is made up of the car-frequencies excited by that particular road surface."

Mr. Olley goes on to discuss the effects of the main frequencies which vary with different cars, the tire frequencies, and the frequencies of the unsprung masses. He further states, "Different types of road excite frequencies of the three groups to different extents." It will be apparent then that the bureau road roughness indicator contains all the elements that exist in the average automobile except, of course, to a considerably different degree. Any recorder actuated by the vertical oscillations of an automobile front axle will show the greatest response to the type of bump which the springs are most effective in absorbing or "ironing" out. Obviously, if a bump on a road is to be felt the



Figure 6. The Viagrahpe-Traceur used in France for delineating the low spots on a pavement preliminary to placing leveling patches.

wheels must lift the car frame and hence there will be relatively less movement between the axle and frame when the shock is not taken up by the springs. While it may be true that rough roads will cause a greater number of vertical movements than will smooth ones, nevertheless a very distorted picture can be obtained from measurements of this type.

German Research

A fairly comprehensive resumé of road profile measuring devices was prepared by Mr. H. Petersen of the Road Research Institute, Technical University, Hanover, Germany, which was published in Strasse in 1939. Many of the following examples or illustrations are taken from Mr. Petersen's compilation.

Undoubtedly, the most simple (even though slow and painstaking) method of gauging road roughness is by means of a straightedge laid on the surface of the road which means, of course, that the straightedge rests on the peaks or high points and the depths of the valleys or depressions are measured from the bottom of the straightedge, a wedge being a convenient means for accomplishing this purpose.

In considering the general problem, it is evident that a true profile of a pavement surface can only be plotted in terms of absolute or relative elevations above some base elevation, sea level, for example. Such profiles are commonplace tools used by engineers for planning and establishing grade lines for roads and are generally developed by plotting elevations from level notes. However, such a process becomes very time consuming and requires painstaking care to produce even an approximately accurate intimate profile of a pavement surface as it will be necessary to take readings every foot or so along the pavement with a high degree of accuracy. However, one or two devices have been built that record the road profile with reference to a carefully leveled beam.

Modification Described

A modification of the simple straightedge is to equip the straightedge with a center wheel that rises and falls as the straightedge is dragged along the surface of the pavement. This is the principle of Brown's pioneer Viagraph and such a device can produce a reasonably accurate record and need not be difficult to construct. However, a straightedge or glider is tiresome and annoying to drag over the surface of a pavement and this drag becomes aggravated if the straightedge is of substantial length.

A third alternative which is an expedient "invented" by many individuals is to equip a beam with one fixed wheel at either end with a center wheel that rises and falls with the inequalities actuating a pointer or a stylus to record this vertical movement on a strip of paper. Many profilometers utilizing this principle have been developed but all have one primary weakness. First, a single bump on an otherwise true surface will be recorded on the graph three times as two depressions and one bump, and if a summarizing counter is used the amount of vertical excursion will be approximately twice that of the true profile. Moreover the aberrations produced by this type of device will vary with the pattern of the road inequalities. A certain sequence of waves can be described for which the recorder will produce a straight line on the graph (Figure 4). These three-wheeled machines will exaggerate some "bumps" and minimize others.



Figure 7. The multiwheel profilometer apparatus of the British Road Research Laboratory.

Three-wheel Viagraph

Figure 5 is an example of a three-wheel device with a rather elaborate recording mechanism which was reported on page 12 of *California Highways and Public Works*, December 1939. This Viagraph was designed by Mr. Claran F. Galloway of the Los Angeles County Road Department.

Meanwhile, developments were proceeding abroad. Most of the devices utilize the principle of the Mailander Wave Measurer developed by the Illinois Division of Highways. Other examples utilizing this principle are shown in Figures 2, 6, 8, 16. Through the courtesy of Mr. Raymond Peltier, Director of Research and Testing, Central Laboratory of Bridges and Roads, Paris, France, information has been furnished on developments in France. Two of the French machines are of interest. One (Figure 6) is a large unit equipped with marking devices which delineate by a series of stripes all of the depressions or low spots on an old pavement. These markings serve as a guide to the repair crews who place thin localized patches to cover the markings and hence improve the riding quality by leveling up the surface. A very ingenious design is also used which utilizes the multiple-wheel principle but in a novel fashion. Here the frame of the machine is carried on two center wheels and the individual bogie wheels are interconnected by a continuous cable running over pulleys. These small individual wheels are free to rise or fall, adjusting themselves to the contour of the road surface and, in effect, provide a reference datum for the vertical movements of the frame supported on the center wheels.

Research in England

One of the more interesting and well engineered profilometers was developed many years ago by the engineers of the British Roads Research Laboratory. This multiple-wheel unit employs 16 wheels but so disposed that no two wheels cross the same transverse joint or inequality at the same time. Figures 8 and 9 show the "classifier" from the British machine. This consists of a series of counters arranged to count each complete up and down movement equal to or

greater than a given value. Figure 10 shows the unique three-wheeled recording unit used on the British machine.

A distinctly different principle is embodied in the "Profilometer" (Figure 11) used on the A.A.S.H.O. test road. As reported by Mr. W. N. Carey, Jr., Chief Engineer for Research, it consists essentially of a trailer unit which is towed over the track by the instrument van at a speed of approximately five miles an hour. As illustrated by the schematic diagram (Figure 12), the slope assembly S measures the angle "a" between pavement P and trailer bed T. Reference R measures angle "b" between the trailer bed and horizontal. As the trailer is towed over the pavement, two voltages are continuously generated proportional to angles "a" and "b." These voltages are added electronically to produce a voltage proportional to angle "c," the angle of the pavement from horizontal. The tangent of angle "c" (slope of the pavement on a nine-inch wheelbase) is recorded as an analog in a recording oscillograph. The record includes pip marks at intervals of one foot on the pavement and other pips indicating the beginning and end of the test section or area of interest.

Operation Speeded

This device has reported advantages such as reasonable speed of operation, good overall accuracy and reproducibility, and the principle permits use of automatic summarization techniques to develop generalized harmonic analyses as a means of converting the wave form into a few numbers. One might judge that the nine inch baseline will introduce some error or aberrations on short wave length bumps. Figures 13 and 14 represent some typical records produced by this instrument. The total cost is reported to be about the same as the California or Michigan Profilograph; namely, about $25,000. Strictly speaking, this profilometer does not produce a profilogram directly although it is possible to reconstruct the profile by means of an electronic chart reader and digitizer. Figure 15 shows a comparison between the graphs taken with the test track profilometer and with the Michigan machine (Figure 16), over the same section of pavement. It will be noted that there is little apparent resemblance between the actual profile as recorded by the Michigan Profilometer and the tape record recorded by the test track unit. Mr. Carey has stated that the test track profilometer record is actually the first derivative of the profilogram.

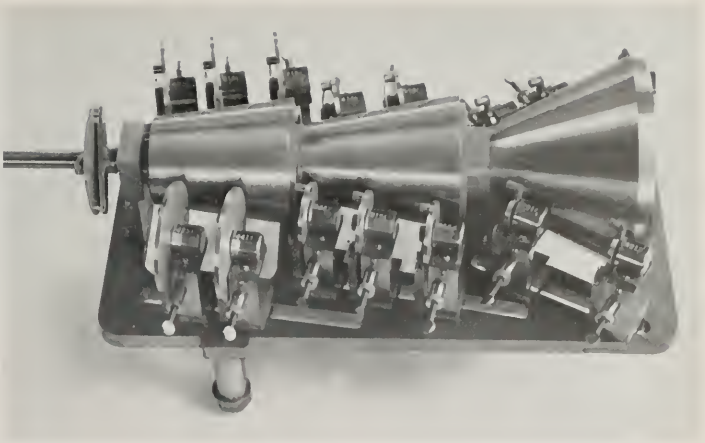


Figure 8. A multiple counter bump classifier used by the British.

Many Approaches

From the variety of devices which have been developed and promulgated by different individuals and agencies, it is evident that this problem has been approached from many different viewpoints, and it is not likely that all will agree upon the relative merits or demerits of the various instruments. It

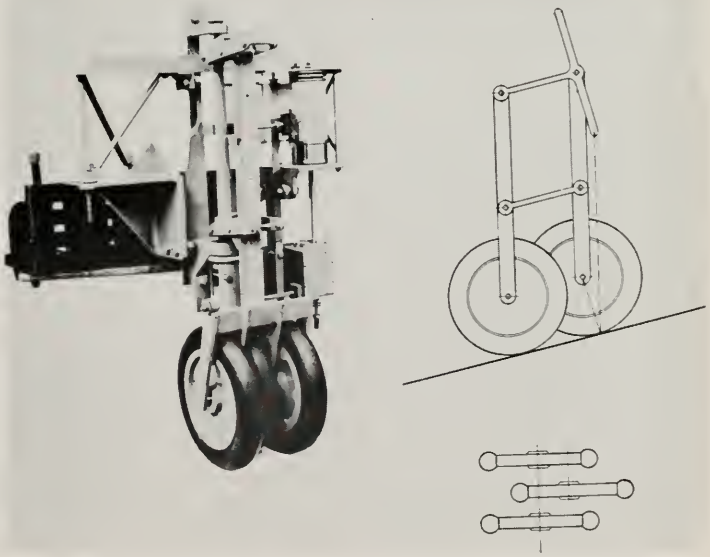


Figure 9. A photo with diagram illustroting the principle of a profile correcting mechanism.

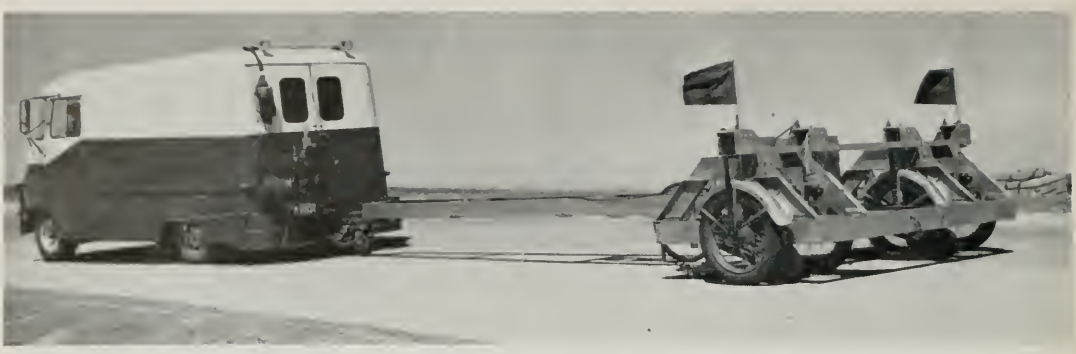


Figure 10. A photograph of the AASHO road test profilometer. (See Figure 11.)



Figure 12. A slope recorder trace of a rough pavement in the AASHO road test (not a profilogram).



Figure 13. A slope recorder trace of smooth pavement in the AASHO road test (not a profile).

seems evident, however, that there are two basic or fundamental differences in the approach. One is to record a profilogram on paper which represents a reasonably faithful picture of the intimate pavement profile. The scale, of course, must be distorted to show up the relatively slight inequalities that are involved in the term "roughness." There are several descriptive terms which are often used more or less interchangeably but which really have different connotations or meaning. One, of course, is the "profile" which represents the contour of the road surface along some single line or path. The term "profile" carries no implication as to whether or not the surface is smooth or rough. The term "pavement roughness" is also frequently used. This, of course, leaves the impression that all pavements must be rough to some degree which, of course, they are.

The second approach is the attempt to measure "riding qualities" which is a term often used more or less interchangeably or confused with the word "roughness." It seems important to emphasize here that the individual who uses a road and drives a vehicle over a pavement is really not much concerned with roughness and even less with considerations of a profile, but is primarily and almost exclusively aware only of the "riding qualities." The term "riding qualities" means the response of a particular individual in a particular vehicle to the particular road surface at typical speeds of operation. The point I wish to emphasize is that an engineer cannot specify such a subjective attribute as "riding qualities" nor can he directly order a pavement contractor to achieve this somewhat elusive condition. By tradition, an egineer or a construction man works to line and grade and hence he can only be expected to produce a finished *profile* within certain limits of variation. We might, therefore, conclude that the profile is the aspect which is of most interest to the engineer.

Basic Assumptions Made

As mentioned by Mr. Olley (quoted above) the roughness of the pavement must be regarded as the source of excitation for the natural frequencies of the vehicle. Most will assume that a perfectly smooth road having neither bumps nor low spots will not excite the vehicle or the passenger and consequently will be smooth riding but there is considerable reason to believe that the most pleasant riding highway surfaces are not those that follow a true plane; on the contrary some undulation in the road surface may break the monotony and definitely add to the pleasant sensations of riding in a motor vehicle. Referring to the profilometer developed and being used on the A.A.S.H.O. test road it might be said to develop some index to the excitation elements in the pavement surface.

It will appear then that the expedients or devices that have been used fall into seven classes which may be described as follows:

. . . Continued on page 68

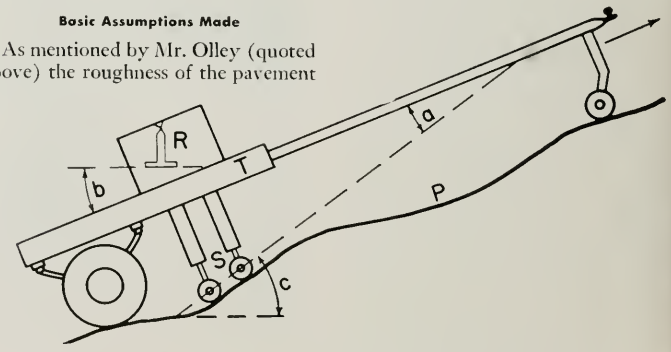


Figure 11. A schematic diagram of the AASHO road test profilometer. (See Figure 10.)

Esplanade

Chico's Historic Roadway Made Divided Four-lane

By E. M. WALL, Resident Engineer

In the 70th anniversary year of its dedication as a monument to the foresight and planning of General John Bidwell, the contract was let in May 1959 for the widening of the main roadway of Chico's famous landscaped Esplanade to accommodate the climbing traffic volume of this rapidly growing Sacramento Valley area.

From dirt to gravel to concrete, it is the fourth surfacing improvement but only the first alteration to the original plan of the Esplanade, with its tree-lined, multipurpose traffic provisions, since it was first laid out 90 years ago—a tribute indeed to Bidwell's vision.

The Esplanade carries one and one-half miles of U.S. Highway 99E from Big Chico Creek, just north of the center of town, to Lindo Channel, about five blocks north of the city limits. It also serves as a main access road to Chico's central business district from the northern residential section. One-way side drives serve the abutting property which is largely residential.

A history of the colorful Esplanade appeared in the May-June 1949 issue of *California Highways and Public Works*.

John Bidwell came to California in 1841 and eight years later purchased a large ranch in the northern Sacramento Valley, then covered with oak trees and tall grass. From this came Chico, founded by Bidwell, and the highly cultivated agricultural area that today surrounds the city.

About 1870 Bidwell planted six parallel rows of honey locusts the full length of what is now the Esplanade. They were all removed in 1914 when they had grown old and maintenance costs had become prohibitive. Two years later they were replaced with six rows of European sycamores, the present trees. The larger part of the Esplanade was annexed by the City of Chico in 1918.

Bidwell designed the Esplanade to carry the heavier carts and wagons as well as through traffic down the center lane which he flanked on either side with a parkway of double rows of trees. In the early days the east parkway was frequently used by horseback riders, and the west parkway was for many years Chico's famous Bicycle Path. With the coming of street cars to Chico, about 1905, the equestrian path was given over to car tracks which are still existent.

Adjacent to the park strips, Bidwell placed outer roadways with a final row of trees that fronted on what later became a choice residential district. Bidwell originally specified that no gravel was to be placed on the side drives, which were reserved for more leisurely travel. But with increasing traffic and the building of fine homes along the Esplanade, the dirt drives became obsolete and were surfaced in 1923.

Roadway is Widened

The graveled main roadway had been replaced with a 15-foot concrete pavement in 1915. Immediately prior to the current widening project the main roadway was a 40-foot, two-lane asphaltic pavement with the original concrete serving as the base of the center. It now has been widened to a four-lane, divided, signalized street with left turn pocket lanes at approximately every other intersection. Previously each cross street went through.



A view of the Esplanade after it had been widened to carry increasing US 99E traffic through the City of Chico. Memorial Way intersection in the foreground.

The side drives were retained as they presently exist.

The new dividing strip will be landscaped with trees and shrubs, except that areas too narrow for planting will be paved. An irrigation system to serve landscaping in the median and remaining separation between the main road and side drives is included in the present contract. Planting will follow completion of the highway as a separate contract.

The project was the result of several years study to find a solution, acceptable to the City of Chico, to Butte County, and to the State, to the problem of handling an increasingly high traffic volume. The 1954 average daily traffic count of 17,500 vehicles, as well as a record of numerous rear-end collisions involving vehicles making left turns, pointed up the need for the present improvement.

Considerable adverse public opinion developed when proposed plans were announced calling for removal of the two rows of trees immediately adjacent to the main road to provide space for necessary widening. The tracks were to remain, but without the separating row of trees. The old Bicycle Path and its inside row of trees was to be eliminated in order to allow for the two additional lanes and new median.

Public Informed

City of Chico officials undertook the job of informing the public about the need of the improvement and its favorable completed appearance. They achieved excellent results through public meetings, mass media, and publication of an illustrated pamphlet showing before-and-after drawings, cross sections, maps of the entire route, and vehicular traffic count chart.

Only one complaint regarding the trees was received at the field construction office, and that was when limbs from trees that were to remain in place were being trimmed to give the required 18 feet clearance above the new pavement.

The project was designed as a joint undertaking by City of Chico, Butte County, and state engineers. The Division of Highways developed the plans and specifications with city and county concurrence on design details. The city and county handled negotiations with the five utility companies whose easements and prior rights-of-way were involved, and acquired necessary additional highway right-of-way near the northern terminus of the job. Ordinarily on state highway projects all the above phases are handled by state personnel.

Bids for the project were opened May 6, with A. Teichert and Son, Inc. of Sacramento low at $490,740.90.

The contractor began tree clearing operations May 26 and removed both rows of trees adjacent to the old main road in about two weeks. Clearing had to be done under heavy traffic conditions, but without serious delay to through traffic. In one instance it was advisable to stop all through traffic for 10 minutes while removing one very large overhanging limb.

Meetings Held

Early after the bid opening, individual meetings were held with each of the utilities concerning relocation of their facilities. Because of the large number of utilities involved, and the possibility of conflicts between the contractor's and utility companies' work forces, a meeting was called of representatives of all utilities, the contractor, subcontractors, and the resident engineer.

During this meeting all were advised of the necessity of keeping through traffic moving at all times. It was also explained that city and county street connections with the Esplanade could be closed only as permitted by the resident engineer, and that all reasonable efforts should be made to see that local residents as well as through traffic have the least possible inconvenience. The work of the contractor and each of the utility companies was discussed, and schedules, including when and where each would work, were set up with the condition that all adjustments to the schedule be cleared through the resident. This arrangement worked out very well and all utilities completed their work within one week of their schedules.

The requirement to keep 24 feet of pavement available to through traffic at all times dictated that southbound lanes—partly lying over the site of the old Bicycle Path—be constructed first. The limited working width, approximately 28 feet, in which to construct the southbound lanes created several problems. One major obstacle was the requirement to compact original ground to 30 inches below finished pavement grade.

Various Methods Tried

The roadway section was first cut to subgrade elevation, 17 inches below finished grade, and various methods and types of equipment were tried to determine which would provide the required degree of compaction. The only method that proved successful was to excavate and windrow a half width at a time to 24 inches below finished grade, and to scarify and compact back to subgrade in four-inch layers with a sheepsfoot roller. The fine, sandy silt material on the site required that the moisture be held to 3 to 5 percent above optimum to get the required compaction.

Because of simultaneous operations by the contractor and subcontractors, care was exercised to insure that the work was done in such a way that no more than two adjacent city streets, or, in some cases, only every other street, were closed at the same time. As a result, a minimum of complaints has been received from adjacent property owners including the few business firms on the Esplanade.

Average daily traffic passing through construction has been 18,000 with 1,400 during the peak hour, 4:30 p.m. Peak-hour traffic has recently increased at the southern end of the project with the start of school. Chico State College, Chico High School, and the Junior High School are all adjacent and have outlet streets to the Esplanade. To date there have been no serious traffic accidents in the construction area.

Ken Fox was project superintendent for the contractor, and D. M. Young was the Division of Highways construction engineer for the project.

INTERSTATE JOB COMPLETED

Highway projects completed during December include 8.8 miles of four-lane interstate freeway on US 40 in the Sierra Nevada Mountains costing approximately $8,952,400.

Grant Line

Bascule Span Drawbridge Built Across Canal With F.A.S. Funds

By CLEMENT A. PLECARPO, Deputy Director of Public Works, County of San Joaquin

On April 27, 1863, the State Legislature approved an act which provided for the legal procedures necessary in order to acquire swamp and overflow lands. On May 26, 1877, William Irwin, Governor of California, signed a patent granting to Tide Land Reclamation Company the title to all lands between Middle River and Old River, lying north of "El Rancho Pescadero" (now Union Island and Victoria Island located north of Tracy in San Joaquin County). An attempt to reclaim the land was made by the Tide Land Reclamation Company along with George W. Kidd, Thomas H. Williams and David Bixler. The attempt apparently ended in failure because on April 15, 1879, the company conveyed to Williams and Bixler all of the lands involved.

It was sometime during the period from 1882 to 1890 that Williams and Bixler constructed the "Grant Line Canal," sometimes referred to as the "Bixler Canal." The two men constructed it on their own land north of the "Grant Line," and proceeded with the reclamation of their land with some help from the United States Government, who put a dam in Paradise Cut. Later, Phillip Fabian and others constructed a canal immediately south of the Grant Line Canal using horses with Fresno scrapers. Thus, was a manmade barrier placed between the fertile island country to the north, and the shipping point of Tracy to the south.

On September 6, 1904, the board of supervisors directed the county surveyor to prepare plans and specifications for a steel drawbridge across Grant Line Canal. On May 2, 1905, bids were opened with Clark and Henery of Stockton the lowest of eight bidders at $18,770. The high bid was $24,579. The structure consisted of one 230-foot steel through truss swing span; one 126-foot through truss fixed span; one 70-foot, and one



The new double bascule span drawbridge over the Grant Line Canal constructed by San Joaquin County under the Federal-aid Secondary Program.



The original Grant Line Canal bridge completed by San Joaquin County in 1906. Although still standing, it is incapable of carrying heavy tannage trucks.

60-foot pony truss spans supported on concrete cylinder piers and concrete abutments for a total length of 496 feet. On May 8, 1906, the County of San Joaquin accepted the bridge as completed.

On August 29, 1904, Bixler had conveyed to the County of San Joaquin right of way for a road across Union Island and for approaches to the proposed bridge. On March 17, 1906, Fabian and his associates conveyed for $175 two acres of land for the southern approach. Thus was the manmade barrier broken and a route opened from Stockton through the rich delta islands to the City of Tracy.

Time and the continuing development of mechanical vehicles forced the posting for restricted load of 16 tons per vehicle, 21 tons per semi-trailer combination, and 25 tons per truck and full trailer. Thus was a barrier again placed by man between Tracy and the rich delta islands.

The county attempted to break the barrier in 1946 and 1947 by preparing plans and specifications to construct a new bridge as an F.A.S. project, but the estimate of cost was higher than the county could finance and the project was dropped.

In 1956, the board of supervisors, upon the recommendation of Mr. L. H. Bradley, the Director of Public Works for San Joaquin County, authorized the construction of the Grant Line Bridge as an F.A.S. project and on July 26, 1957, a joint field review was held at the site with state, county and federal representatives in attendance. An agreement was made between the State and the county whereby the Bridge Department of the State Department of Public Works would design and prepare the plans and specifications with the county assuming all of the costs. This work was done under the direction of W. C. Kiedaisch. The bridge consists of 12 reinforced concrete slab spans, and one double-leaf bascule span with a lightweight concrete deck, about 471 feet in total length supported on prestressed concrete pile piers, prestressed concrete pile abutments, and reinforced concrete piers with concrete pile foundations, and providing a clear roadway width of 28 feet.

On September 19, 1958, a contract was awarded by the Department of Public Works to Erickson, Phillips and Weisberg, they being the low bidder for $588,847. Ross Phillips was the superintendent for the contractor, who prosecuted the job so capably that the bridge was completed several months ahead of the time limit.

In the late summer of 1959, the County of San Joaquin awarded a contract to A. Teichert and Son, Inc., for the construction of bridge approaches and that portion of Tracy Road (F.A.S. 907) between Grant Line Canal and Old River, at a total contract cost of $95,675.48. Herman Smith was superintendent for the contractor.

Preliminary and construction engineering were performed by San Joaquin County under the direction of L. H. Bradley, Director of Public Works. C. W. Hedstrom was resident engineer for both the bridge and road projects, and I feel did an outstanding job on a difficult project.

On November 5, 1959, dedication ceremonies were held. Many county, state and City of Tracy officials participated, including Supervisors Bruce McKnight, W. R. Ruggles, Edmond Heinbockle, and C. B. Bull, without whose help the project would not have been possible.

Thus, at a cost of about $700,000 the barrier between the Tracy area on the south, and the island area and the City of Stockton on the north, has been broken.

So ends another chapter in the history of the "Grant Line."

Visitors

Foreign Engineers From Many Nations Study L.A.'s Freeways

By MILTON C. STARK, District Information Officer

The State of California, with its 7,500,000 motor vehicles use 14,000 miles of state highways and freeways, has become a world leader in highway development. It is, therefore, only natural that many countries wishing to improve their transportation facilities would seek information here, where modern highway and freeway construction has been pioneered and developed.

District VII of the State Division of Highways has in this respect been a popular meeting ground for foreign engineers from many countries. Within the space of a single month the district has been host to engineers from Japan, Switzerland, Australia, New Zealand, Denmark, Sweden, Viet Nam and India.

A team of Japanese engineers, headed by Dr. Kiyoharu Utsumi, President of the Japan Construction Mechanization Association of Tokyo, visited District VII on September 14 and 15, on one leg of an inspection tour that takes them through the United States to observe techniques in the heavy equipment field. The team was traveling under the auspices of the International Co-operation Administration of Washington, D.C. Accompanying the 12-engineer team was Ramsey Stobie of Training Within Industry, Incorporated, and Mr. Howard Christensen of the U.S. Bureau of Public Roads.

The engineers were briefed on policies and procedures of the State Division of Highways by E. T. Telford, Assistant State Highway Engineer, in charge of District VII. Also on hand to discuss construction methods and equipment was Ike Brown, Assistant General Manager of the Associated General Contractors.

Freeway Tour

On September 15 the Japanese group toured District VII freeways, which included picture taking at the four-level structure, and a trip over portions of the Golden State Freeway, the Ventura Freeway and the Mulholland Cut on the San Diego Freeway.

Guides on the tour were Herb Belford of the Construction Department and Fred Fujimoto, Project Engineer of Design A who also acted as interpreter. Fujimoto served as interpreter for the United States Army in the Far Eastern Theater during World War II.

The Japanese engineers were impressed with the extent of the District VII freeway system and the enormous traffic loads it carries. They felt that their own traffic complex on the islands of Japan—1,700,000 motor vehicles on 6,000 miles of paved highways—could benefit from adoption of a highway and freeway program modeled after our own.

Following the Japanese delegation came engineers from Australia, New Zealand, Denmark and Sweden. The more numerous Swedish group arrived in the district office on October 5 and spent two days discussing and touring local freeways, aided by guides James McMahon, Southern Area Bridge Engineer, and Bruce Gentry, Construction Engineer.

As acutely interested in freeway progress as their Japanese forerunners, the Swedish group shot film and took candid shots of the four-level structure in the Civic Center, later making an inspection trip over portions of the Santa Monica, Golden State, Santa Ana and Harbor Freeways. The engineers took on-the-spot notes on port-



Bruno Wildermuth, Swiss engineer (center) views an aerial photographic map of the Greater Los Angeles Freeway System with District Engineers L. R. Gillis (left) and A. L. Himelhoch (right).



A. K. Aga (left), chief town engineer for Jamshedpur, India, confers with E. T. Telford, Assistant State Highway Engineer (Los Angeles Times photo).



A group of engineers and officials from Japan visit the four-level grade separation in downtown Los Angeles. Standing at right is Ramsey Stobie of the Training Within Industry Corporation of Cleveland, Ohio, who led the group on their tour.

able wire recorders for later transcription.

New Technique Used

McMahon found that the visitors were very much interested in bridge building, design and construction, particularly in our use of single column bents, box girders and prestressed concrete and that these techniques were in use in their own country. A unique bridge building procedure used in Sweden is the construction of reinforced concrete bridges by cantilevering out from concrete piers balancing the successive pours. This practice is not prevalent in the United States for reinforced concrete bridge construction, although it is common procedure for structural steel bridges.

Swedish concern with bridge building is occasioned by growth of highway transportation and the fact that many of their roads must pass over deeply indented shore lines, rivers and islands.

On October 13, 1959, a Swiss engineer from Zurich, Bruno Wildermuth, called at the district office, culminating an 18-month stay in the United States, during which he was employed by American engineering firms and attended engineering courses in New York City and at the Institute of Transportation and Traffic Engineering at Berkeley, California.

Wildermuth came to the United States, and especially to California, to research transit and transportation problems and relate them to freeway development. According to Wildermuth, Switzerland, too, is facing growing traffic problems and will require an expanded network of mainline highways to bolster its present overtaxed system which is handling an estimated 600,000 motor vehicles. He noted that the trend in transporting persons and goods is via the highways, and that the metropolitan street car lines and the railways increasingly are occupying a secondary place; hence, the necessity for freeway or expressway planning in Switzerland. The Swiss driver pays 85 cents per gallon for his gasoline, 80 percent of the tax revenue from which is used by the Swiss government for construction of the national highways that are built by both cities and cantons to uniform standards, as with our own interstate highways. Swiss automobiles are all imports, fueled by petroleum products from the Near East, yet cost of gasoline in Switzerland is less than in any other neighboring country.

Viet Namese Road Builders

Even distant South Viet Nam, the Far Eastern country bordering the South China Sea and formerly known as French Indo China, is giving its attention to a new road building program to meet the demands of a growing economy. It is a country of some 11,000,000 inhabitants occupying a land area of approximately 700,000 square kilometers; it has 14,000 kilometers of paved and unpaved roads extending through mountainous terrain. South Viet Nam's 100,000 motor vehicles, 30 percent of which are trucks, pay 40 cents per gallon for gasoline.

Here in the United States on a 2½-month tour to study road construction techniques were two Viet Namese, Nguyen Van Dinh, Director General of Public Works, and Nguyen Huu Tuan, Bureau of Foreign Aid, Ministry of Public Works.

The Vet Namese officials, who arrived in Los Angeles on October 16, said that Viet Nam was constructing 200 miles of new roads per annum with American financing and technological assistance. Their purpose in visiting District VII was to study road construction, maintenance methods and equipment.

At the conclusion of their visit they were taken on a field inspection trip over portions of the Angeles Crest and Pearblossom Highways by Howard Christensen of the U.S. Bureau of Public Roads.

A. K. Aga, Chief Town Engineer for the City of Jamshedpur, India, conferred with engineers in the District VII Office and was taken on an inspection tour of Los Angeles freeways during the week of October 19.

Aga said that the rapidly expanding City of Jamshedpur now has need of a freeway to handle the growing numbers of motor vehicles. A 280-foot right-of-way carrying two lanes of traffic each way and centered by some sort of railway is planned. There will be another slight difference between the Jamshedpur freeway and ours: It will have to have some provisions for bicycles.

WARLOW ELECTED

The California Highway Commission has elected Chester H. Warlow of Fresno its vice chairman to succeed James A. Guthrie, San Bernardino, who has served as vice chairman for the past year.

REMODELING OF S.F. TRANSIT TERMINAL CONTINUES



Included in the remodeling of the Transbay Transit Terminal in San Francisco was the installation of a new stairway flanked on both sides by escalators leading from the lobby to the mezzanine level.

Included among the improvements planned by the Division of San Francisco Bay Toll Crossings in connection with the reconstruction of the San Francisco-Oakland Bay Bridge is the rehabilitation of the Transbay Transit Terminal. A ruling of the Public Utilities Commission ordered the abandonment of train service across the bridge and into the East Bay, which became effective April 20, 1958.

The elevated track area from the San Francisco Anchorage which faces Beale Street in San Francisco, around the Terminal Loop, and through the building, has now been repaved and the 14 motor coach lines of the Key System Transit Lines are now operating out of the terminal, thus relieving the city streets of this traffic.

Since the abandonment of train service, the transit terminal has been operated by the State. A program providing for the general rearrangement of the various services in the building and the refurbishment of both the interior and exterior of the structure has been started.

Included in this remodeling was the construction of a new stairway to the garage area below the street level, the installation of fluorescent lights in the main waiting room and on the mezzanine floor, the opening of various previously closed areas for freer movement of pedestrian traffic throughout the building, the constructing of a new ticket office, and the installing of a new stairway flanked on both sides by escalators, leading from the lobby to the mezzanine level.

The escalators are 48 inches wide and transport 135 passengers per minute at slow speed, and 180 passengers per minute at fast speed. The direction of the moving stairway can be changed to accommodate peak traffic flow in either direction. All possible safety devices have been incorporated in their installation.

The terminus with its new facilities and the improved transit service to the East Bay should induce a larger number of persons to use public transportation. With buses transporting an average of 22 passengers per trip, compared with less than two persons per car, the traffic congestion on the bridge, particularly during the peak periods, would be somewhat relieved.

Chemical Engineer E. D. Botts Retires

Dr. E. D. Botts, Senior Chemical Testing Engineer, retired on January 1, 1960, after 10 years of service with the Materials and Research Department and a total of 25 years in state service.



DR. D. E. BOTTS

Botts is widely identified with the excellence of paints used by the Division of Highways for improved traffic striping and the protection of structural steel. In recent years he has pioneered the use of epoxy resins as binders and adhesives and has received national recognition for his work.

He was born in Missouri in 1893. He attended schools in Missouri and Oregon and later received his Ph.D. degree at the University of Wisconsin.

Botts served in the U.S. Army during World War I. In 1924 he became chief chemist for American Marine Paint Co. in San Francisco. From 1928 to 1944 he was a professor of chemistry at San Jose State College. Subsequently he acted as a technical adviser to the Small War Plants Corporation and the U.S. Department of Commerce at Los Angeles. He also served for two years as research chemist with the Veterans Administration at the Birmingham Hospital in San Fernando Valley.

In 1950 he came to the Materials and Research Department as Senior Chemical Testing Engineer, a position he has held until his retirement.

Botts was married in 1929 to Gretchen Kroncke. He and Mrs. Botts have left Sacramento on a three-month tour around the world after which they expect to resume their residence in Sacramento.

BILLION MARK PASSED

A summation of the Division of Architecture's construction program over the 20-year period 1941 through 1960 (including projects under consideration for the 1960-61 Budget) totals over $1 billion.

Freeway Benefits

Madera Freeway Reduces Accidents, Congestion, Recent Survey Shows

Based on a recently completed comparison of accidents before and after it was opened to traffic last year, the new Madera Freeway can be credited with a large reduction in traffic accidents and persons injured and killed.

E. W. Taylor, District VI Traffic Engineer, reports that during the last year when all U.S. 99 traffic used the former F Street route through Madera, there were 154 accidents reported by the California Highway Patrol and the Madera City Police Department in the 3.7 mile section that was later superseded by the freeway. The freeway was opened to traffic on October 1, 1958, and during the one-year period until September 30, 1959, there were only 33 accidents on the former route, now designated as "U.S. 99 Business," and 15 on the freeway. This total of 48 represents a 79 percent decrease.

The number of persons injured and killed also showed a marked decrease to less than half the former number, it was reported by Taylor. During the last year before the freeway was opened, there were 49 persons injured and one killed on the F Street route, while only 15 were injured on the old route and seven on the freeway during the year ending September 30, 1959, a total of only 22. No fatalities have occurred on either the business route or the freeway since the latter was finished.

In terms of the number of accidents in relation to the volume of traffic, the comparison indicates the pronounced effect freeway construction has on accident frequency, even on a superseded route. During the last prefreeway year, the accident rate was 7.9 accidents per million vehicle miles of travel on the former route. This dropped to 6.5 accidents per million vehicle miles for the portion remaining on the F Street route for the smaller amount of traffic it carried after the freeway was opened. The freeway rate is a very low 0.9 accidents per million vehicle miles, lower even than the statewide average of 1.2 for all California freeways.

Recent traffic counts show that the average daily traffic on the freeway is now about 12,700 vehicles, with an additional 4,300 a day using the Business 99 route. The sum of these is a 2 percent increase over the 1958 average volume carried by the F Street route.

Other advantages accruing since the freeway was opened were outlined in the following editorial entitled "Some Freeway Hindsight" from the Madera *News-Tribune* of November 27, 1959:

> It has been over one year and two months since Madera's new freeway opened (September 1958). As a result, there has been considerable adjustment for many F Street businesses. After the initial loss of traffic, it seems a reasonable amount has been regained.
>
> We notice a good flow of customers at the principal restaurants. Readers will recall that experts predicted an immediate loss of business for all those dealing with through highway traffic. They said this would gradually readjust with a gainback of through traffic stopovers and better local use because of improved traffic conditions. Whether the previous peak would be reached could not be assured, because it depended on quality of service and proper advertising.
>
> We feel this has been fairly well accomplished. At least northbound traffic has an easy ingress to the city via F Street. It is harder for southbound traffic to get off the

. . . *Continued on page 62*



A view of the Madera Freeway looking north at the Fourth Street overcrossing. Landscaping of the freeway includes the planting of oleanders along the dividing strip and pyracantha on the slopes.



A low-lying species of pyracantha was planted on the slopes of the Madera Freeway to give an effective yet attractive ground cover.



A view of the Madera Freeway showing the turnoff for local traffic at the south end of the city.

FREEWAY BENEFITS

Continued from page 60 . . .

freeway, due to the overpass necessary. This, at least, doesn't look as inviting to the travel as the south entrance.

Service stations, naturally, have suffered the most. Some have just closed up and taken other locations. Grocery stores, lumber yards and other retail businesses have profited the most. Their businesses are more easily accessible than before. Who can forget crossing F Street in the midst of noisy truck and tourist traffic, plus local cars and trucks. It was hazardous, to say the least.

At any rate the depressed freeway on old H Street seems to have been accepted. Cross-town traffic has been improved and access to Highway 99 certainly from Fourth Street and Olive Avenue, is simple.

In keeping with its promise, State Division of Highways has landscaped the depressed section sides. When the plants mature, a park-like effect will be for all to see who pass through Madera. Local residents also, we are sure, will view with pride the total effect.

Sign Fee Increase Is First Since 1933

A revised schedule of permit fees for advertising signs along California's highways and county roads will be in effect in 1960.

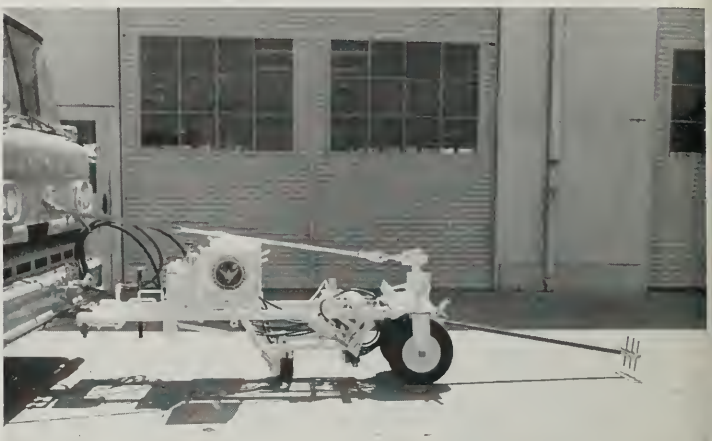
The 1959 Legislature increased the fees for permits and licenses issued under provisions of the California Outdoor Advertising Act, which regulates the placement and design of signs and billboards along state highways and county roads outside incorporated cities.

The fee increases are the first since the act was adopted in 1933. The money from permit and license fees, approximately $125,000 a year, is used by the Division of Highways to pay the cost of administering the act.

According to this statute, signs must meet minimum state requirements so as to have no adverse effect on traffic safety or highway efficiency. Signs must also conform with local land use and zoning ordinances independently administered and enforced by many of the counties.

Sign permits are issued by the State on a calendar-year basis and must be renewed each year.

NEW STRIPER MODEL OPERATED FROM TRUCK CAB



Experimental model of new traffic striping unit developed by the Equipment Department at its headquarters shop in Sacramento. This model will replace the unit that requires the operator to ride in the sulky (See photo below).

The Equipment Department has long recognized the advantages of moving the traffic line striping machine operator out of the sulky, pushed by the striping truck, and into the truck cab. This change will be advantageous from both safety and economy standpoints, and will result in a more simplified striping unit.

To attain these advantages, the Equipment Department has developed a traffic striping machine that is completely controlled from the cab of the paint truck. The new unit has been completed and is now operating on a test basis. The results of this actual operation will give the department additional information necessary to further the usefulness and productivity of the new machine.

Many states and foreign countries use the same general type of striping equipment developed by the Equipment Department years ago. Many of these states and foreign countries have expressed interest in the new unit. It is estimated that this new unit will cost less to manufacture, and will paint more stripe at less cost per mile with more safety for the operator.

The unit was designed, constructed and is being tested under the supervision of Associate Equipment Engineer James J. Keleher of the Equipment Department.



Current model of traffic striper used by the California Division of Highways. This model, developed by the Equipment Department, is in use in many other states and many foreign countries. The unit will be replaced by the new self-contained unit that is operated from the truck cab (See photo above).

Upon final completion and testing, details and photos of construction and operation will be presented in this publication.

INTERSTATE PROJECTS

From July 1, 1956 (the start of the Interstate Aid Highway Act of 1956) to December 31, 1959, 83 interstate contracts totaling $286,085,500 had been awarded in California.

'Tempus Fugit' Corner

Twenty-five years ago. The following items appeared in the January and February 1935, issues of *California Highways and Public Works.*

NO "DEATH CURVES" HERE

Views of the completed 3.5-mile improvement of the northern section of the famous Ridge Route (between Fort Tejon and Grapevine Station) show that the former dangerous curves and narrow roadway have been replaced by a fine, safe three-lane modern highway.

GAS TAX CONTINUES DOWNTREND

In spite of ideal weather conditions, improved roads, and normal summer and fall prices, sales of gasoline have been decreasing steadily since May of 1934 with the exception of October. With only the returns for December to come, it appears that the total assessments for 1934 will fall slightly below the figure for 1933, with a probable total for the year of $39,000,000.

SOUTHLAND ROUTES BEING MARKED WITH NEW STATE SIGNS

Rapid progress is being made by sign-posting crews of the Automobile Club of Southern California on erection of the new-type numbered route signs on main state highways. Seven thoroughfares are now being signed and two more will be posted within the next few weeks.

"OFFICIAL STATE HIGHWAY PLEDGE" Urged by Women's Community Service Auxiliary Committee of L.A. Chamber of Commerce

"I pledge devotion to the Highways of our Country, to the preservation of their existing natural beauty and to the intelligent development thereof; that our highways may serve not only as arteries of the nation's commerce, but through their beauty bring *peace and joy* to those who travel them in their hours of leisure."

UNEMPLOYMENT RELIEF

The Division of Highways program to speed the advertising of construction projects which are financed from the 1935 federal grant of the Hayden-Cartwright Act has the entire state highway organization keyed to a high pitch in order that all projects shall be under contract by July 1 * * * this program is one of the primary factors in the *relief of unemployment* in California today.

BIENNIAL BUDGET

The *biennial* state highway budget for the 87th and 88th fiscal years, July 1, 1935, to June 30, 1937, shows total amount for major project construction throughout the State will be *$26,498,980.*

Earl Malkson Retires In San Bernardino

Gilbert Earl Malkson, Maintenance Engineer of District VIII, with headquarters in San Bernardino, has retired from state service. He joined the Division of Highways in 1928.



EARL MALKSON

His first division job was as a survey party chief in District VIII. Later he was assigned to the construction department as resident engineer on a highway construction project in the Mojave Desert.

In 1940-41, Malkson was resident engineer on one of the first cement soil stabilization projects in District VIII on U.S. Highway 60-70-99, between Banning and Whitewater.

In 1943 he was transferred to maintenance duties as a highway superintendent. He was promoted to his present position in 1947.

Malkson was born in Snohomish, Washington, in 1893 and attended public schools there and in Lake Stevens, Washington. His first engineering job was as a construction foreman and hydrographer in 1913 with the Central Oregon Irrigation Company, where he remained until 1920. He spent two years with the City of Redmond, Oregon, as water and street superintendent. Before coming to the California Division of Highways he was employed eight years as a locating engineer with a private civil engineering firm in Bend, Oregon.

IN MEMORIAM

Headquarters Office

Harry B. Milner, Supervising Highway Engineer; Sam Osofsky, Highway Economist; John W. Vickrey, State Highway Engineer.

District I

Wallace L. Chapman, Assistant Right-of-Way Agent; Eugene Meyer, Associate Highway Engineer; LaVern M. Robinson, Highway Foreman.

District III

Helen Laaste, Highway Engineering Technician; Edward J. Nunes, Assistant Highway Engineer.

District IV

Gabriel Flaviani, Laborer; Grace Modica, Intermediate Typist-clerk.

District V

Paul H. Tarbox, Engineering Aid II.

District VII

Lawrence P. Friel, Senior Right-of-Way Agent; Paul C. Gibbons, Stock Clerk; Albert Martinez, Laborer.

District VIII

Clarence R. Cox, Laborer.

District IX

Irven D. Hartley, Highway Leadingman.

Bridge Department

Leonard M. Flannigan, Intermediate Clerk.

Materials and Research

George D. Ralph, Assistant Highway Engineer.

Bay Bridge

Joy D. Wade, Toll Collector.

OLD ISSUE WANTED

A copy of the April 1924 issue of *California Highways,* forerunner of *California Highways and Public Works* magazine, is needed to complete a set for binding. If you have one to spare please send it to the editor.

L. V. Campbell

Lawrence V. (Pat) Campbell, retired Division of Highways engineer, died on December 21 after a short illness.

In April of 1953, he retired as engineer of city and co-operative projects of the division after 33 years of service.

Campbell was born in Louisville, Ky., in 1888. He attended high school in Louisville and graduated from Rensselaer Polytechnic Institute of Troy, N.Y., in 1910.

He started his career with the State in 1915 but left to serve as a second lieutenant in the Army engineers during World War I. Before returning to state service in 1922 he was employed by Sacramento County, the Nevada Highway Commission and the Montana Highway Commission. Campbell served as office engineer of the division for 11 years before his appointment to the city and co-operative projects post.

Campbell was a member of the American Society of Civil Engineers and the honor engineering society, Tau Beta Pi. He was also a member of the Golden Empire Council of the Boy Scouts of America and one of the founders of cub scouting in Sacramento.

He was active in obtaining a retirement system for state employees.

He is survived by his wife, a daughter, Mrs. Eugene M. Gray of Sacramento and a son, Lawrence Pike Campbell II of Paris, France.

TOSS OF COIN DECIDES

It required a coin toss to determine the "low bidder" on a project for 1.3 miles of fencing on U.S. Highway 101 in San Luis Obispo County.

Anchor Post Products, Inc., and the San Jose Steel Company, Inc., submitted identical low bids of $18,237.40.

The two firms broke the tie in the time-honored manner. Anchor Fence Post won the toss.

Office Engineer H. C. McCarty of the Division of Highways said there have been identical bids submitted before, but they are so rare he could not remember when the last one occurred.

Department Submits New Palisades Study

Director of Public Works Robert B. Bradford has submitted to Governor Edmund G. Brown and the Legislature a report on measures proposed to control landslides along the Pacific Palisades in the Santa Monica area.

The report was prepared by the Department of Public Works in conjunction with the City of Los Angeles, Los Angeles County and the City of Santa Monica. It is based on a study made by the New York City consulting firm of Moran, Proctor, Mueser and Rutledge.

Remedial measures proposed in the report in general follow the recommendations of the consulting engineers, as announced last August. However, the State's engineers expressed some reservations as to how closely cost estimates may fit final plans. The consulting engineers estimated an overall cost in excess of $6,000,000 which would include installation of drains, the construction of berms or benches in some locations, and the partial filling of some canyons.

The recommendations cover 12 locations along the Palisades.

For East Pacific Palisades, the area of the "big slide" of 1956 and subsequent slides, it is proposed to intercept ground water by a 2,380-foot tunneled gallery and lateral drain system 40 to 60 feet below the surface in sound material and to regrade and drain the upper 100 feet of the material in the slide.

To reduce the hazard of a northerly progression of the big slide, it is proposed to grade the top of a steep intact promontory and build a bench at the toe to intercept small soil falls before they reach the highway.

The report stated:

"With reservation on applicability of cost estimates to final detailed plans, the proposal is recommended with confidence." The consultants' preliminary cost estimate was $933,900 for the East Pacific Palisades work.

The report was prepared under authorization of the 1957 Legislature, which made an appropriation of $300,000 from the State Beach Fund available for the study.

Division Announces Recent Retirements

District I

James J. Garfield, Highway Equipment Operator-Lab., 32

District II

John P. Carlton, Laborer, 23

District III

Owen E. Davies, Groundsman, 8

Perry R. Lowden, Supervising Highway Engineer, 34

District IV

Harry M. Paul, Highway Leadingman, 24

District V

Francis LeRoy Clayton, Highway Equipment Operator-Lab., 18

Walter S. Pratt, Highway Engineering Technician, 12

District VII

Walter E. Crooks, Highway Leadingman, 26

Sylver P. Dane, Senior Stenographer-Clerk, 28

Walter R. Waugh, Highway Landscape Supervisor I, 22

District IX

Loyd C. Jordan, Highway Leadingman, 13

District X

Russell J. Woodward, Assistant Highway Engineer, 13

Materials and Research Dept.

Elbert D. Botts, Senior Chemical Testing Engineer, 25

Headquarters Shop

Frank E. Furrer, Automobile Mechanic, 13

Anita Edna McEnery, Intermediate Account Clerk, 17

Shop 11

Roscoe I. Linn, Automobile Painter, 16



ooking southeast along construction on the San Diego Freeway skirting the City of San Clemente. A completed portion of the freeway can be seen in the background.

Continued from page 19 . . .

Route 19 Freeway

This route for 16.6 miles between the Santa Ana Freeway in Orange County nd the Pomona Freeway in Los Angeles County, traversing as it does a portion of Brea Canyon, is sometimes ocally referred to as the "Brea Freeway." It was declared a freeway by the Highway Commission in 1956. It trav-rses the Cities of Orange, Santa Ana, Placentia, Anaheim, Fullerton and Brea.

Preliminary designs are now in prog-ess in the district office. The only ex-enditures to date have been those ecessary in the acquisition of prop-rties to protect rights of way. Ex-enditures to date for this purpose total 323,000.

Outlook for Future

One measure of the fiscal problems f the past year is that the total value f contracts under way has decreased rom $88 million on October 20, 1958, o $85 million on November 20, 1959; nd of the construction under way on November 20, 1959, only contracts with a total value of about $51 million will remain uncompleted on March 20, 1960. To this we hope to add new contracts to bring the total of work under way to a value of about $70 million as of March 20.

The spring of 1960 is obviously going to be a lean period for construction. Following that, we anticipate that it will be possible to place work under contract at an average rate of somewhat more than $10 million per month.

Based on our best estimates, it appears that the following portions of the freeway system may be opened to traffic in 1962:

Golden State Freeway—Complete within the City of Los Angeles.

San Diego Freeway—Jefferson Boulevard in Culver City to Burbank Boulevard in San Fernando Valley and from Long Beach Freeway to 174th Street.

Santa Monica Freeway—Santa Ana Freeway to Hoover Street, including Harbor Freeway Interchange.

Newport Freeway (Orange County)—Santa Ana Freeway to Riverside Freeway.

Freeway through City of Ventura (US 101)—Telephone Road to northwest of Ventura River.

We have had a serious construction delay during 1959 and a substantial reduction in the interstate highway program amounting to $70 million statewide in the 1960-61 fiscal year. This is regrettable but the program that now appears possible on the basis of existing federal and state laws offers the possibility of sound progress for the future. It is to be hoped that no changes or unforeseen obstacles develop.

Resident Engineer Retires February 1

William T. Rhodes, long-time resident engineer for the State Division of Highways in San Diego, retired February 1, 1960. Rhodes, who was employed by the State for 39 years, acted as the State's representative on numerous construction projects both in the central as well as the southern portion of the State. During his career he developed a number of aids to highway engineering. Among them the "Rhodes arc," which rapidly calculates the relationship of horizontal to slope distance for surveyors, is the widest used. Other innovations have been "Rhodes ready reckoner," for determining pavement depth during construction, and "Rhodes temporary striping," consisting of white-painted tar paper which is glued to new paving with asphalt binder to delineate traffic lanes through new construction.

Rhodes, Dekema said, has probably participated in highway development and growth during its greatest period of change. He has supervised construction projects ranging from two-lane desert highways to the complex US 80 freeway between Grossmont Summit east of La Mesa to Chase Avenue in El Cajon.

Rhodes and his wife, Marguerite, plan an extended trailer tour. They will maintain their residence in San Diego.

A.A.S.H.O. COMMITTEE STUDIES STATE'S FREEWAYS



George M. Webb, Traffic Engineer for the State Division of Highways and a member of the special AASHO committee (seated left) points to something of interest on the map to other members of the committee which includes (seated right) C. W. Prisk, Director of Highway Safety Studies for the U.S. Bureau of Public Roads, and (standing, left to right) T. S. Huff, Chief Engineer of Design, Texas Highway Department; Joseph Barnett, Deputy Assistant Commissioner of the Bureau of Public Roads; J. D. Lacy, Chief of the Plans Analysis Branch of the Bureau; E. L. Sherertz, Engineer of Design for the Illinois Highway Department; and H. W. Griffin, Chief Road Engineer of New Jersey.

A COMMITTEE of freeway experts, representing the American Association of State Highway Officials, spent several days in California in the course of a nationwide study to examine freeways in operation in the Los Angeles and San Francisco metropolitan areas.

The committee began its visit to Los Angeles on November 9, with a conference at the District VII Office of the Division of Highways. City and county engineering and enforcement officials, and motorists organization representatives were invited to participate. Inspection tours of various Los Angeles freeways followed.

The same pattern was repeated in the San Francisco area, on November 12.

The committee, which is designated as the Special Freeway Study and Analysis Committee, was established by the A.A.S.H.O. a year ago at the suggestion of Federal Highway Administrator B. D. Tallamy.

The job of the committee, as spelled out in A.A.S.H.O. proceedings, is to study freeways in operation in various states and to "study the various geometric designs involved and their relationship to operational difficulties and accident patterns, and to make recommendations to A.A.S.H.O. on those features of design that should be encouraged and those that should be avoided in designing future highways."

Chairman of the committee is R. R. Bartelsmeyer, chief highway engineer of Illinois and immediate past president of A.A.S.H.O. (he was represented on the California study tour by E. L. Sherertz, engineer of design for the Illinois Highway Department). The secretary is Joseph Barnett of Washington, D.C., Deputy Assistant Commissioner of the U.S. Bureau of Public Roads.

The committee also inspected freeway operation in the New York, Detroit, Chicago, Houston, and Dallas areas.

U.S. Travel Miles Exceed 664 Billion

Total motor-vehicle travel in the United States in 1958 amounted to 664.7 billion vehicle-miles, an increase of 2.7 percent over the 647.0 billion figure for 1957, according to figures released by Bertram D. Tallamy, federal highway administrator. The travel data were compiled by the Bureau of Public Roads, U.S. Department of Commerce, from information supplied by the state highway departments and toll authorities. For 1959, total travel is estimated at 696 billion vehicle-miles, based on reports for the first three-quarters of the year.

Of the 1958 travel, 40 percent was performed on main rural roads, comprising 14 percent of the nation's total of 3.5 million miles of roads and streets. Another 46 percent of the travel was on urban streets, which comprise only 11 percent of the total mileage. Local rural roads, which make up 75 percent of all mileage, accounted for only 14 percent of the travel.

Passenger cars represented 83 percent of the vehicles and performed 82 percent of the travel in 1958; trucks and combinations accounted for 16 percent of the vehicles and 17 percent of the travel; similar figures for buses were less than 1 percent.

The average motor vehicle traveled 9,658 miles in 1958, almost half of it in cities, and consumed 776 gallons of fuel at a rate of 12.44 miles per gallon. The changes from 1957 were too small to be considered significant.

The average passenger car traveled 9,494 miles in 1958, an increase of 1.1 percent over the 9,391-mile average in 1957, and consumed 664 gallons of fuel in 1958 as compared with 652 gallons in the previous year. The average passenger-car fuel-consumption rate of 14.30 miles per gallon in 1958 was 0.7 percent lower than the 1957 rate of 14.40, but the difference is not statistically significant. Fuel consumption rates of buses and trucks remained virtually unchanged from 1957 to 1958.

APPOINTMENTS

Continued from page 2 . . .

sign), and the American Society of Photogrammetry. He is a member of the Commonwealth Club and of the Elks.

He has been for the past few years a member of the transportation committee for the VIII Winter Olympic Games in Squaw Valley.

Womack has twice been called on as a consultant in highway planning for foreign countries. In 1953 he served as consultant on a study of highway deficiencies for the Government of Haiti. He was retained by the Japanese Government to make a route study between Tokyo and Kobe in 1954 and prepare a report on construction and bond financing for a road which is now under construction.

Womack is married and has two sons. His home is at 2653 13th Street, Sacramento.

Murphy Promoted

Murphy has been Assistant State Highway Engineer (Administration) since October 1957. He has been an employee of the Division of Highways for nearly 30 years.

A native of Pittsburgh, Pennsylvania, Murphy came to California as a child and grew up in Bakersfield. He attended the University of California at Berkeley, receiving his degree in civil engineering in 1930.

The same year he began his career with the Division of Highways as a construction inspector in District II (Sacramento-Marysville). He remained with District III until 1938, when he moved to Headquarters Office in Sacramento as assistant to the federal aid engineer.

During World War II Murphy was a Marine Corps officer, with service in the South Pacific. During the later months of the war he was Division Engineer Officer of the Second Marine Division. He held the rank of major upon separation from active duty.

He returned to Sacramento after the war, and was appointed Construction Engineer of District V (San Luis Obispo) in 1947. The following year he returned to the Marysville Office as Assistant District Engineer, and in 1950 transferred to Headquarters Office as a principal highway engineer in charge of public relations. Responsibility for personnel management and related functions was added to his duties in 1955.



G. A. Hill

Early in 1957 he was transferred to the position of Advance Planning Engineer for the Division of Highways, and served in that capacity until his promotion later that year to Assistant State Highway Engineer.

Murphy and his wife Dorothy live at 5812 Wymore Way, Sacramento. They have two children, John and Dorothy.

Gillis, who succeeds Murphy as Assistant State Highway Engineer (Administration), was District Engineer (Planning) for District VII in Los Angeles.

Gillis Appointed

A native of Walla Walla, Washington, Gillis moved to California as a youth and completed high school in Sacramento. He received his civil engineering degree from the University of California in 1938, and has since been with the Division of Highways except for military service during World War II and the Korean Conflict.

His first three years in highway work were spent on the planning survey staff in Sacramento. In 1941 he moved to District IV (San Francisco) and moved steadily up the promotional ladder in that district, with experience in traffic, utility relocation, construction, and design.

Early in 1956 he was appointed District Engineer in District VII, first in charge of operations and then planning. For the past two years he has been responsible for the location and design of freeways and other highway improvements in Los Angeles, Orange and Ventura Counties, along with budgeting and other related functions.

Gillis, who is married and has two daughters, has made his home in Arcadia. He is the son of Ridgway M. Gillis of Sacramento, who retired in 1955 as Deputy State Highway Engineer.

His wartime military service was in the Navy Civil Engineer Corps. He holds a World War II commendation from Fleet Admiral Chester Nimitz. During the Korean Conflict he was in charge of design and contract construction for the 12th Naval District.

Hill to L.A.

Hill, who succeeds Gillis, has been chief assistant to the Engineer of Design in the Sacramento Headquarters Office of the division. Born in Oakland, he graduated from Fremont High School and received his degree in civil engineering in 1937 from the University of California. He joined the Division of Highways the same year and served most of the next nine years in District VI (Fresno), except for military duty with the U.S. Army Corps of Engineers in Alaska and the Pacific during World War II.

In 1946 he went to Yale University for a year's graduate study in traffic engineering. Upon his return he was assigned to District IV (San Francisco), and served there until 1953 in construction, traffic analysis and planning functions. He was in charge of analyzing the first major origin and destination survey of the home-interview type, which was conducted in the Bay area in 1947-49.

In 1953 Hill was promoted to supervising highway engineer rank and transferred to the design department in Division Headquarters Office in Sacramento. Since 1955 he has been chief assistant engineer of design.

Hill, his wife and son have lived in Davis. He is a member of the Institute of Traffic Engineers and of the Forum Toastmasters Club of Sacramento.

PROFILOGRAPH

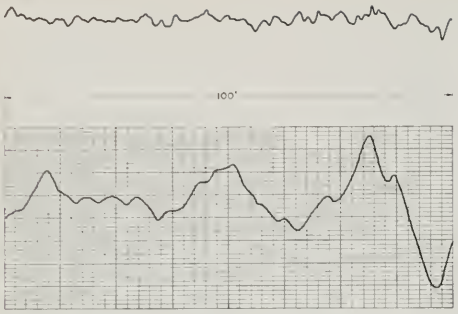


Figure 14. A comparison between a record from the AASHO slope recorder (top line) and one made by the Michigan Profilograph (lower line).



Figure 15. A photo of the Michigan Profilograph unit modeled after a California design.

Continued from page 52 . . .

1. Plotting a profile from level notes taken at frequent intervals along the pavement with rod readings to the nearest .001 foot.
2. Measuring deviations from a straightedge laid on the surface of a pavement in which the reference plane corresponds to the average of the two highest spots within the length of the straightedge.
3. Profile records plotted by the movements of a center wheel in a three point contact system. In other words, a beam equipped with a single wheel at either end and with a recording wheel in the center free to move in a vertical plane.
4. Recording vertical oscillations of a wheel with reference to a suspended weight or mass; for example, movements of the front axle of an automobile or movements of a wheel in a specially constructed device such as the U.S. Bureau of Public Roads road roughness indicator (Figure 3).
5. Devices in which the reference plane represents the mean of a number of points of contact with the road surface in the vicinity of the point being recorded.
6. Devises to mark the pavement to delineate either high or low spots as desired. The most elaborate of this type known to the author is the "Marking Viagraphe" developed and used in France. This machine, instead of examining a single line, marks a considerable width of pavement in one operation (Figure 6).
7. A novel device developed by the staff on the A.A.S.H.O. test road is equipped with two wheels nine inches apart in tandem with electronic means for constantly measuring the slope of all inequalities on the road surface. This device does not give a direct picture of the road profile but it is stated that the data could be interpreted to give a profilogram if desired (Figures 11, 12, 13, 14, 15).

TWENTY-FIVE-YEAR AWARDS

Employees who received twenty-five-year awards since those listed in the July-August edition of *California Highways and Public Works*

DIVISION OF HIGHWAYS

District I
Leonard E. Craig
Alton D. Cromwell
Harry D. Hicker

District II
Jess B. Doyle
Harold E. Goode

District III
Abraham Salgado

District IV
Leroy R. Cardwell
Wilder G. Morey
J. F. O'Brien

District V
Russell A. Adams

District VIII
David R. Henderson
Francis Royal
Joe R. Solomon

District IX
Robert L. Pruett

District XI
John A. Hoffman
James D. McCain
Raymond L. Potts
Richard F. Anderson (Dec. 1958)

Headquarters Office
Ohla C. Hinton
Ferdinand J. Volkert

Bridge
Lawrence E. Crayne

Bay Bridge
Georgia Max
H. C. Snead
Rollin H. Taylor
Martin G. Van

Shop 7
Edward A. Lavery

DIVISION OF CONTRACTS AND RIGHTS-OF-WAY
George C. Hadley

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Paper Cites Human Factor in Freeway Crashes

The following editorial, under the title "Soon: Tall Double Line," appeared in the Palo Alto *Times* for December 21, 1959:

Two persons were killed and four severely injured a few days ago when an automobile careened across the dividing strip of Bayshore Highway at Candlestick Point and hit an ice cream truck. Occupants of the car had been drinking, its owner said.

The tragic collision left four children fatherless and three motherless only a few days before Christmas. But tragedy alone did not explain the prominent news display that a similar crash on the old Bayshore Highway a decade ago never would have gotten.

Newspapers hit the story hard because such collisions are so rare on the freeway. The coverage was a testimonial to the effectiveness of the divided freeway in reducing the frequency of "across the double line" smashups.

State highway engineers are close to making freeways even safer by perfecting barrier fences for installation in the center strips of freeways throughout California.

Two barrier models are undergoing final tests. The one considered most likely to be selected has cables interwoven in a chain link fence. It is designed to stop a vehicle whose driver is intoxicated, ill, asleep or intent upon suicide from crossing the dividing strip and colliding with oncoming traffic. At the same time, it is engineered so an automobile hitting it won't bounce back into the lanes from which it came.

As long as a human factor remains in driving, the engineers probably won't be able to make us completely safe. But we are grateful for each highway terror they abolish.

The letter below was sent by the State Highway Engineer to the editor of the *Times* following the appearance of the above editorial:

Editor, Palo Alto Times
Palo Alto, California

DEAR SIR: Your editorial of December 21, entitled "Soon: Tall Double Line," emphasizing the safety engineered into modern freeways, was most gratifying to the Division of Highways for two reasons.

One reason, of course, is that we appreciate any mention of our continuing efforts to make freeways as near fool-proof as possible. The freeway safety picture is clear from statistical records—the fatality rate on freeways is about one-third the rate on the other highways—but the spectacular headlines on the occasional spectacular freeway tragedy make an understandably stronger impression on most people than do the statistics. This is particularly true of cross-median accidents on freeways, which account for less than 20 percent of all freeway accidents that result in fatalities. Your editorial helps to put this picture in its proper perspective.

Our other particular interest in your editorial stems from your constructive emphasis on the "human factor" in traffic safety. This is also brought out by statistics—about 90 percent of all accidents involve a violation of the Vehicle Code—but it needs constant reiteration to build it into the consciousness of the individual motorist, whose prime responsibility for the safety of himself and others on the road cannot be delegated to the engineers or anyone else.

Sincerely,

J. C. WOMACK
State Highway Engineer

A.A.S.H.O. ELECTS WOMACK

State Highway Engineer J. C. Womack has been elected to the executive committee of the American Association of State Highway Officials, to fill the two-year term originally held by the late J. W. Vickrey.

EDMUND G. BROWN
Governor of California

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1929

In February 1931 a large group of motorists gathered in Red Rock Canyon, eastern Kern County, to dedicate a new section of highway. They came in their Fords, Buicks, Chevrolets, Dodges, Essexes, Maxwells and Chandlers from Mojave, San Bernardino, and even drove the long miles from Los Angeles to celebrate completion of the final contract of the many required to build a serviceable road between Mojave and Bishop.

Orators included two members of the California Highway Commission and the District IX Engineer, F. G. Somner. In his speech Mr. Somner said, "The completion . . . of the contract . . . sets at rest forever the terrors of Red Rock Canyon, the greatest barrier to travel within District IX, owing to the old road having occupied the floor of the canyon, subjecting travelers to the dangers of being caught in the roaring currents from periodical cloudbursts originating within a vast drainage area at the head of the canyon."

This optimism was somewhat premature. Although the construction of 1930-31 elevated the highway about 15 feet, flash floods continued to be a maintenance problem. Last year the road was once again modernized with increased bank protection and wide, four-lane roadway. The photographs show the road as it was when it followed the stream bed, and as it is now.

1959



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The Mulholland Summit Cut on the San Diego Freeway in Los Angeles (right portion of the above photo) is already approaching in size the Big Cut of the Carquinez Project. The curving four-lane highway approaching the tunnel is the existing highway (Sepulveda Boulevard). The roodway thraugh newly excavated ground above it is Mulholland Drive. (See "Report From District VII," this issue.)

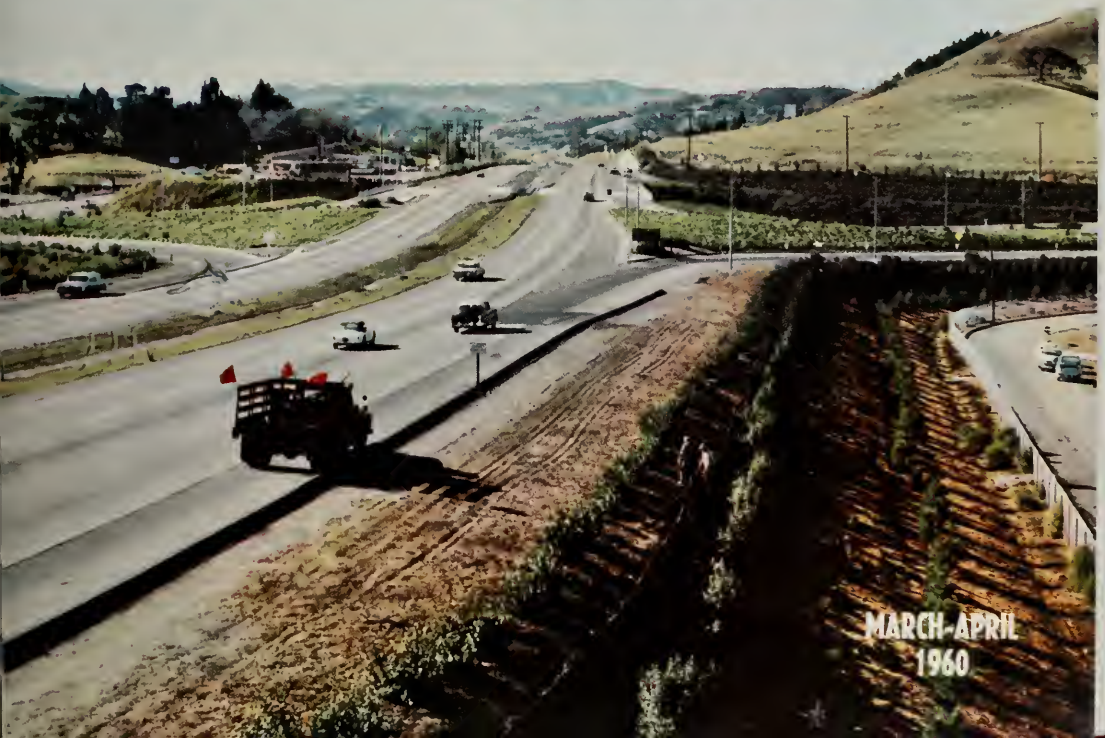
Construction of the first phase of the future Santa Monica-Harbor Freeway interchange (the bridges across the Harbor Freeway) is now completed. The full eight-lane detour around the construction site, which carried 190,000 vehicles a day, has now been removed. This will be a part of the freeway loop around downtown Los Angeles now under construction. (See "Report From District VII," this issue.)



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CALIFORNIA Highways and Public Works



MARCH-APRIL 1960



*Traffic moving from State Sign Route 89, lower left, into Squaw Valley in February during Winter Olympics of 1960. Squaw Peak is peak farthest left, KT-
to the left and below it. Two sections of Navy's compacted snow parking area are nearly filled with cars, another at right center about half filled. Games or
concentrated beyond parking spaces. Road along right side of valley is for official cars and local residents—cars are entering at left on compacted snow*

See story on Olympics traffic on page 35.

California Highways and Public Works

Official Journal of the Division of Highways, Department of Public Works, State of California

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FRONT COVER

UPPER—A landscaped portion of the Nimitz Freeway through an industrialized area in the City of Oakland. Foreground is planted with pyracantha and redwoods.

LOWER—Landscaping at the Pleasant Hill Road interchange on State Sign Route 24 between Oakland and Walnut Creek. Rows of plants in the foreground are Monterey pines and California holly which will form both an attractive and effective traffic noise deterrent screen. Photos above and below by Jack Meyerpeter.



BACK COVER

Installation of new large-size directional signs on the Walnut Creek Freeway Bypass. For a description of this newly completed bypass see "Freeways in District IV" beginning on page 13 of this issue.

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State Growth

Governor's Conference Studies Urban Area Traffic Outlook

City and county planning officials, administrative officers, highway engineers and others participated in the Governor's Conference on California's Urban Areas and the State Highway System in Sacramento February 23 and 24. They undertook to study current problems of exploding urban growth and motor vehicle use and to explore an approach to future problems of a state expected to have more than 31 million people and more than 17 million motor vehicles in 1980.

The conference, held in the Eaglet Theater, dealt with the problems under these major headings:

1. Present and future growth, planning and development in urban areas and the California highway system.
2. The growing inter-relationships of governmental agencies in future urban development.
3. Goals for 1980 and beyond in urban growth and expansion of the state highway system.



Governor Edmund G. Brown paused to chat with Ira J. Chrisman (seated), Mayor of Visalia and President of the League of California Cities, as he left the rostrum after addressing delegates to the Governor's Conference on California's Urban Areas and the State Highway System held in the Eaglet Theater Sacramento, February 23 and 24. At the right is Robert B. Bradford, Director of the State Department o Public Works, who was general chairman of the conference.

Governor Speaks

"Clearly, we have work to do," said Governor Edmund G. Brown in welcoming the approximately 200 delegates. "And," he said, "if projections about the future are valid, the task is monumental. How shall we proceed?

"First, our transportation plans must embrace more than highways and freeways.

"Second, we must recognize that our efforts to cope with the movement of large groups of people as they go about their work and play necessarily impinges on all phases of a community's life. As we come into an area with a network of concrete, what we do will very likely influence the future of that area for decades to come. This is true not only of an area but of the State as a whole.

"Finally, we must understand that our highways and other mass transit systems are more than links between the present points of origin and the present destinations of multitudinous individuals; they influence what our *future* points of origin and destination will be. They are, in other words, a positive conditioning force in shaping the pattern of our lives. To say this is to say that we must be sure we are looking at the whole picture as we plan our transportation facilities.

"Also, we must never forget that, in this dynamic, growing State, looking ahead takes on a new dimension; it is virtually a condition of survival."

Problems Outlined

Governor Brown told the delegates that in calling the conference he had in mind three basic problems:

First, the problem of relating metropolitan freeways to other systems of transportation;

Second, the problem of reconciling state and local jurisdictions in the area of highway planning;

Third, the problem of relating highway planning to other aspects of community life, both at the state and local levels.

In regard to the reconciliation of state and local jurisdictions in the area of highway planning, Governor Brown said that the State Division o Highways had recognized that to day's highway systems are bound t have a profound impact on local areas and that local interests must be con sulted.

"I know that the heads of our high way division are ready and willing t co-operate with local jurisdictions, he said, "but I am convinced that sti more can be achieved. I am sure tha conferences such as this will furthe the already good day-to-day workin relationships that prevail."

Bradford Is Chairman

Robert B. Bradford, Director Public Works, was general chairma of the conference, but each discussio panel had its own chairman.

Ira J. Chrisman, president of th League of California Cities and may of Visalia, was the opening speak following the Governor's address welcome. Chrisman told the confe ence:

"The vast scope of highway co struction under way and conte

. . . Continued on page

Crossroads

Completion of Two Major Connections Joins Riverside, San Bernardino Freeways

By LOREN BARNETT, District Construction Engineer

"Resident Engineer calling Barricade Crews—Open Freeway!"

Flowers falling on Resident Engineer Tom Borman's car from the dedication ceremony on the overcrossing above were his signal to radio the standby crews to open the "missing link" of the San Bernardino Freeway.

The flowers were dropped at the climax of a double ceremony that started earlier in the day when a "missing link" in the Riverside Freeway was also dedicated.

It was appropriate that these freeways should be dedicated jointly as, in addition to each being a "missing link" within its own freeway, the main San Bernardino and Riverside Freeways were also linked together at the "crossroads" interchange just east of Colton).

These freeways were connected at night a few months before with two cranes hoisting prestressed concrete girders in place over existing traffic. During this operation, the light predawn highway traffic was interrupted less than 30 minutes at any one time. The railroad was bridged with no delay to train traffic.



Railroad Conflict

This smooth operation was in sharp contrast to an important traffic connection in 1883 when the California Southern Railroad (now Santa Fe) was bringing its line up from San Diego and attempting to cross the pioneer S.P.R.R. at Colton.

A tussle ensued between the two railroads. The S.P. placed a heavy engine at the point of crossing, but was finally compelled to move the locomotive to save it from demolition. (Records indicate the S.P. finally failed in laying the disputed tracks.)

From this initial crossing grew an intolerable entanglement of railroad and highway traffic. Over 70 years later, a tremendously increased volume of cross-country and local traffic was still trying to cross near the same point.

The final phase to the solution of this entanglement was realized with the completion of the big three-level "crossroads" interchange.

This massive interchange has been appropriately referred to as the "Crossroads of the West," since the following main highways converge at this location:

- U.S. Highway 395, San Diego to Canada
- US 99, Calexico to Canada
- US 91, Long Beach to Canada by way of Las Vegas and Great Falls
- US 70, North Carolina to the Pacific Ocean
- State Highway 18, Long Beach to Victorville via the San Bernardino Mountains and the Mojave Desert

Southword Extension

From this "crossroads," the newly completed link of the Riverside Freeway heads south, bridges the main Southern Pacific Railroad line, and extends out across the historic Cooley Ranch—one of the few rural farmlands remaining in this area. It slices through the high bluff of Grand Terrace, passes under the Santa Fe and Union Pacific Railroads, and, at the Riverside county line, ties into the previously constructed portion of the Riverside Expressway that carries the traffic on into Riverside.

This freeway is a typical rural freeway design with widespread interchanges, each covering considerable acreage.

An unusual problem was encountered on this project in providing protection for an existing utility. The planned freeway passed over an old water tunnel which was first con-



Dedication ceremony on the Ninth Street Overcrossing. Left to right are: Millie Askew, who is Miss San Bernardino; Mrs. Davida Gadfrey, San Bernardino pioneer; and James A. Guthrie, member of the California Highway Commission.

structed in the 1870's as part of a system for transporting irrigation water to the Riverside area. The tunnel was still in use and it was questionable how long the lining would last, considering its age and makeshift construction.

The tunnel was originally supported with 6-inch by 8-inch redwood roof timbers resting on brick piers. It was lined with two-inch redwood planks on the ceiling, four inches of concrete between piers on the walls, and three inches of concrete on the floor.

In the 1920's, concrete mortar wa pasted over the entire walls an ceiling.

The problem was to provide a new support to 530 feet of this tunne without reducing the water-carrying capacity. The solution was an arche corrugated metal tunnel liner wit pressure grout filling the voids be tween the liner and old walls, an air-blown mortar placed on the inside of the liner to provide a smoothe flow.

Not Much Headroom

Placing the tunnel liner and con crete with only approximately fou and one-half feet of headroom pose a problem that could not be solve with normal construction methods an equipment.

The contractor for this work, N M. Saliba Company, tried severa methods of getting the concrete bac into the tunnel, including wheeling by hand "buggies," by pumping, an by the use of a hopper mounted on monorail and propelled with a five horsepower engine.

The powered monorail unit wa found to be the most practical metho in transporting the concrete long dis tances into the tunnel. It was also use to remove old concrete and to carr the liner plate into the tunnel.

After the metal liner was bolte into place, grout was forced in be



Looking north from the 16th Street Interchange on the San Bernardino Freeway.



A southward view from the 16th Street Interchange on the San Bernardino Freeway.

ween the old and new linings with pumping unit set up in the tunnel. Air-blown mortar was applied to ne inside of the corrugated liner with onventional pressure grouting equipent located outside of the tunnel umping dry sand and cement through oses to the site of the work in the nnel, where it was uniformly mixed ith water just prior to application. With this new smooth lining—even ough reduced in section—the tunnel n now carry the same volume of ater as it did with the old rough ning and with assurance that the tunel will not collapse under the freeay.

Freeway Connection

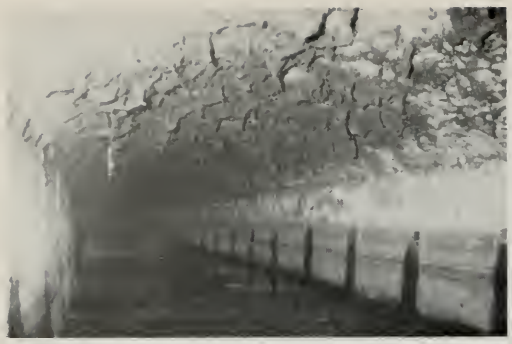
The other "missing link" is north the "crossroads" interchange. It is rt of the San Bernardino Freeway d extends from the center of San rnardino to the northerly city nits, where it ties onto the Barstow eeway.

It was also necessary to co-ordinate te freeway with an existing railroad. ere, portions of two mainlines of the nta Fe tracks were shifted to ease rp curvature to accommodate minim standards of a parallel freeway ngside.

This freeway, in contrast to the verside link, is of urban-type develment with more compact interanges that utilize and tie into the y street system.



An aerial view of the newly completed section of the San Bernardino Freeway.



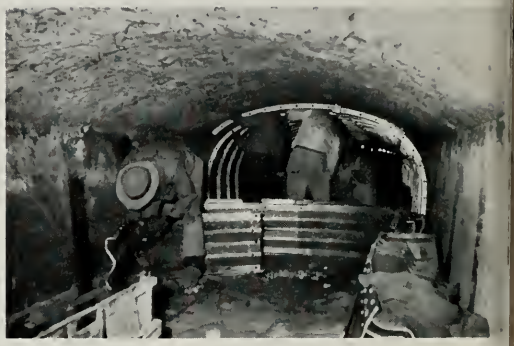
The tunnel before construction. Note the brick piers in the walls. The ceiling is covered with dirt-encrusted cobwebs.



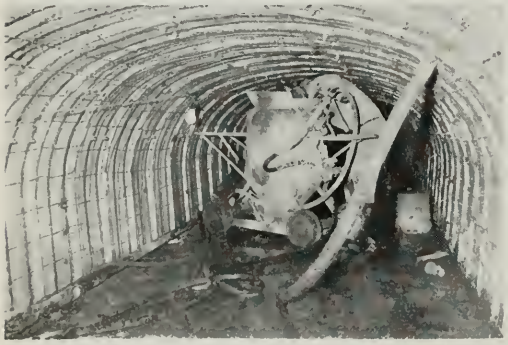
The tunnel after it had been reconstructed.



Pouring the floor slab with a manorail unit.



A crew placing the tunnel liner.



Forcing grout between the new and old tunnel lining.



Applying air-blown mortar to the inside of the new tunnel lining.

An example of compactness is illustrated by the condensed interchange at the 16th Street area, where the railroads, both freeway roadbeds, and three ramps all blend together, with the 16th Street Overcrossing spanning the whole network (see picture).

With the freeway and railroads lying adjacent, special consideration had to be given to the design of the ramps. The solution resulted in all but one ramp entering or leaving the freeway from one side. It was possible to provide separation from local traffic for both the freeway and railroad with single overcrossings.

A most effective method was used in blending these freeways into the surrounding terrain by the transplanting of existing ornamental trees. On the San Bernardino Freeway, a group of old olive trees were transplanted on a curve between the railroad and freeway. These trees served the dual purpose of landscaping and providing a shield from train headlight glare. On both of these freeway units, many



An aerial view of the "Cross Roods" Interchonge east of Colton.



The narth partion of the newly completed section of the Riverside Freeway.

"specimen" palm trees—some about 100 feet high—were transplanted into suitable settings at the interchanges.

During construction of the San Bernardino link, a native pioneer lady, Mrs. Grace Clark English, approached the resident engineer and told him of having carried water to a very small palm tree when she was a little girl. It had been brought to their place from Palm Canyon (near Palm Springs) in about 1884.

With the development of the freeway, Mrs. English moved to a new location adjacent to the freeway, but the palm tree had been left in the path of construction. She said she hoped her palm tree could be saved.

An ideal setting for this palm tree developed at the Orange Street On-Ramp. It is now visible to the passing motorist as well as from the window of Mrs. English's new home. She is again carrying water to help get her palm re-established.

The San Bernardino Freeway is now complete as a divided highway, permitting a 125-mile nonstop trip from Los Angeles to Barstow.

The Riverside Freeway is now complete as a divided highway, permitting a 100-mile nonstop trip from Corona to Barstow.

The dedication ceremonies celebrating the completion of these freeways were planned co-operatively by the San Bernardino, Riverside, and Colton Chambers of Commerce. Under the general chairmanship of George W. Savage, the celebration was completed with a large reception and dinner at the National Orange Show. Many dignitaries attended the ceremonies, including the Director of Public Works, Robert B. Bradford; Governor Lic. Braulio Maldonado of Baja California; Highway Commissioners James A. Guthrie and A. T. Luddy; Representative Harry R. Sheppard; U.S. Senator Thomas H. Kuchel; and State Senator Stanford C. Shaw.

With the completion of the "missing links" in the San Bernardino and Riverside Freeways, the giant "Crossroads of the West" interchange is now rapidly and efficiently sorting a mixture of intercity, interstate, and intercontinental traffic, and is discharging a much happier motorist.

US 50 Freeway

State Begins Construction on MacArthur Freeway in Oakland

By L. M. PETERSEN, Design Engineer, District IV

After many years of planning and right-of-way activity, including two district public meetings and two California Highway Commission hearings, the construction of U.S. Route 50, Interstate Route 5W, in Alameda County between the San Francisco-Oakland Bay Bridge and Castro Valley is under way. It is expected that sufficient funds will be provided on this section of interstate freeway to permit continued construction until completion.

This 15.3-mile section of US 50 is unofficially called MacArthur Freeway since it roughly parallels MacArthur Boulevard through much of its course. The route was adopted between the Bay Bridge distribution structure and Route 228 at Castro Valley in three units; in January 1955, May 1957 and June 1957, respectively. Freeway agreements covering this section were negotiated with the several local authorities involved between November 1956 and December 1958.

A total of $23,000,000 has now been budgeted for construction.

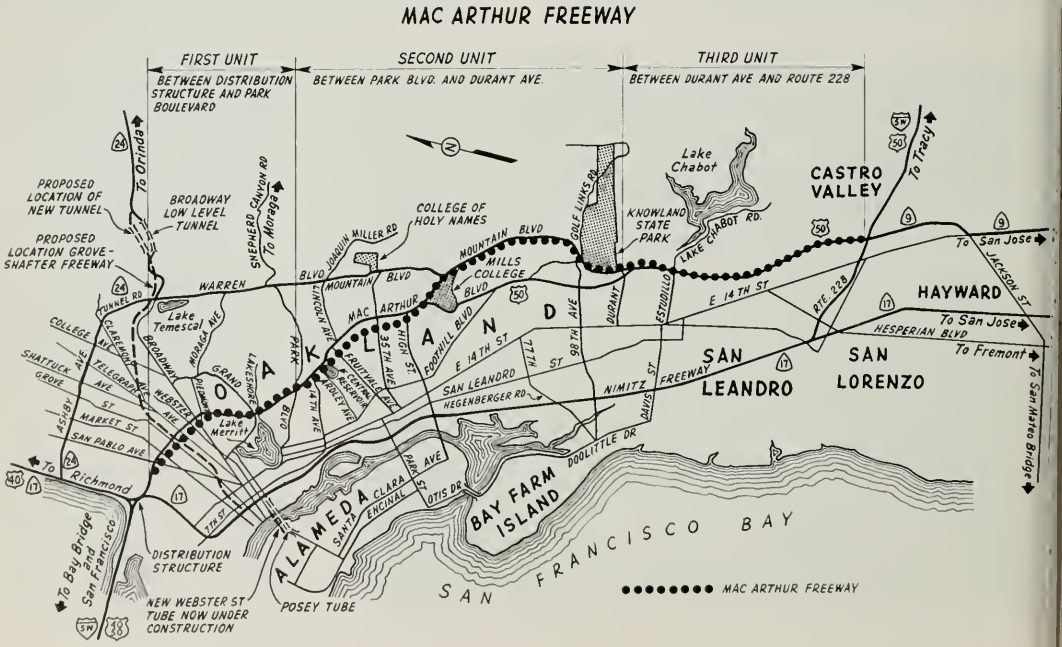
The 1959-60 budget includes $10,000,000 for construction from the distribution structure to Market Street and from Webster Street to Grand Avenue in Oakland. Bids have been opened on the first of these units and the second has been advertised.

Will Close Gap

The 1960-61 Budget includes $13,000,000 for construction on two projects, the first to close the gap between the two projects financed in the 1959-60 Budget and the second to provide construction between Grand Avenue and 14th Avenue. It is expected both these projects will be advertised during 1960. These four projects will provide an eight-lane freeway between the Bay Bridge distribution structure and 14th Avenue for a length of about 3.9 miles.

The area traversed is nearly fully developed and improved. Most of the parcels required are residential in nature although many of them are multiple units. There are many other types of properties involved, however, such as churches, mortuaries, a burlesque theater, a soft drink producer, retail stores, service stations, cafes, motels and trailer courts.

The total cost for the entire 15.3 mile section is estimated to be about $100,000,000, about evenly divided



between construction and right-of-way.

Right-of-way purchases began soon after the first section was adopted in 1955. Over $34,000,000 has been spent to date on right-of-way with an additional $9,400,000 budgeted. Out of some 2,100 parcels required, about 1,600 have now been purchased. Funds now programed are sufficient to purchase right-of-way for nearly

BORROW, EXCAVATION WORK COMBINED; SAVINGS RESULT

The result of co-ordinated planning among several departments has been evident since work was started February 11, 1960, on the first unit of the MacArthur Freeway. The contractor, C. K. Moseman and Son, is excavating at the east portal site of the future third Broadway Tunnel bore. This excess material will considerably reduce the cost of constructing freeway embankments in the metropolitan area between the distribution structure and Market Street in Oakland.

This borrow operation will continue through the next three contracts to provide the 350,000 cubic yards of embankment needed between separation structures extending to Broadway. Material is hauled through the existing tunnel and on the state highway during off-peak traffic periods. Subsequent contracts, beginning at 14th Street, will contain sufficient excavation to balance the grading beyond Broadway.

l the remaining parcels required for he full 15.3-mile section.

Most Parcels Acquired

Nearly all the parcels have been urchased on the portion for which onstruction funds are now budgeted etween the distribution structure nd 14th Avenue, and about 90 per-ent of this section has been cleared. asterly of 14th Avenue right-of-way egotiations are well advanced and earing is under way. Slightly less an half the improvements cleared to ate have been moved and the re-ainder demolished. Because of the



Looking westerly across Oakland residential area from vicinity of Grand Avenue, showing right of way clearance for proposed MacArthur Freeway.

advanced age of many of the buildings and scarcity of vacant properties in the area, it has been difficult to salvage even that amount. Some enterprising contractors have moved houses down to the bay and barged them up the San Joaquin River to the Stockton area.

The right-of-way purchase and clearance activities have been spread over several years to permit orderly readjustment of residents and businesses.

In selecting the route for this freeway, an attempt was made to effect a minimum of disruption to public facilities such as schools, parks, etc. In spite of this, the route crosses a portion of the City of Oakland's Lakeshore Park and Knowland State Arboretum and Park and requires some revision of playground facilities of the Lakeshore School on Grand Avenue in Oakland. A small portion of an EBMUD reservoir near Ardley Avenue will have to be cut off and rebuilt. At all of these locations, an attempt is being made to provide a minimum of disruption and a pleasing finished facility consistent with proper freeway standards.

On National System

Since this freeway is on the national system of interstate and defense highways, interstate design standards are being maintained. Eight lanes are to be constructed throughout with 60-mile-per-hour design speed pro-

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Conference

Collier, Backstrand, Armstrong Keynote Road Meet at U.C.L.A.

ROAD BUILDING is the world's second oldest profession, and like the world's oldest profession, it suffers greatly from the criticism of the amateurs who think they are better qualified than the professionals."

When Senator Randolph Collier made this statement in his speech to the opening session of the 12th California Street and Highway Conference in Los Angeles January 28, he received a delighted outburst of applause from the audience of city, county, and state engineers and other officials gathered in Schoenberg Hall at the University of California at Los Angeles.



RANDOLPH COLLIER

The Senator, who heads the Senate Transportation Committee, pointed out the many difficulties which arise in allocating highway funds in California, and discussed the great task confronting the engineers to make the highways safer. He said the annual death toll on the highways of the United States would make a line of hearses from Los Angeles to Salt Lake City.

Backstrand Stresses Safety

Assemblyman Lee Backstrand of Riverside County, who is chairman of the Assembly Transportation and Commerce Committee, spoke the same morning in the same vein.



LEE BACKSTRAND

"Based on a projection of present trends," Backstrand said, "700,000 more persons will have lost their lives in traffic by 1975, 25 million more will have been injured, and the total cost of motor vehicle accidents to the people of the United States between 1958 and 1975 will exceed $120 billion."

Speaking of future problems, Backstrand pointed out that "three-fourths of all adults in the United States are now licensed to operate motor vehicles, and safe highway transportation has consequently become a universal need close to the heart of the nation's welfare."

Co-operation Stressed

Keynote speaker for the opening day program was Ellis L. Armstrong, Commissioner of Public Roads, U.S. Department of Commerce. Armstrong devoted the major part of his speech to the problem of financing the interstate program, and the many organizations which must co-operate to make the program a success.

"In stressing the big and varied task that lies ahead," Armstrong said, "I want to emphasize both the array of talent and the professional skills that are found in our state highway departments and the counterparts in the local highway fraternity. You make up a very special elite—competent experts of high integrity and ability and perseverance dedicated to the public service.



ELLIS L. ARMSTRONG

"I know you by personal contact and by reputation. Suppose we also let the record speak. The vastly increased scope of the federal workload is implicit in dollar and mileage figures for the interstate and other federal aid systems—planning, construction, and completions are entirely up to expectations.

"Since the passage of the 1956 Highway Act over 100,000 miles of highways, including 20,000 bridges, have been constructed across America on the federal aid system, at a cost of about $8 billion. This includes nearly 5,800 miles of high-standard interstate system roads and the remainder on the regular primary, secondary, and urban systems. In addition, construction is now underway on 23,000 miles of highways and 8,800 bridges. Of this total, 4,300 miles is of interstate roads, the rest is the regular ABC work."

Air Car Described

At the general session which closed the conference on Saturday morning, January 30, the group was addressed by Minard W. Stout, Vice President for Research and Development, Curtiss-Wright Corporation. Stout spoke on the potential of the air-cushion car and showed a motion picture film of progressive experimental models developed by his firm. The company claims its production model, soon to be available, is already perfected enough to travel on conventional highways, and that wide use of the machines for travel will eliminate the need for bridges over water, and all but the most rudimentary type of road surfacing.

During the Saturday morning session, addresses were made by State Director of Public Works Robert B. Bradford, ex-Director C. M. Gilliss, now Executive Director, Los Angeles Metropolitan Transit Authority, and Keneth M. Hoover, chief engineer, San Francisco Bay Area Rapid Transit District.

Bradford spoke on the subject "Transportation Planning Calls for Team Effort." As one example, he cited "the relationship that has existed for more than 40 years between the United States Bureau of Public Roads and the various states, especially the California Division of Highways. We have all taken for granted how smoothly the accelerated Federal Interstate Highway Program has gone into effect and how rapidly it has progressed—yet very few of us have stopped to think what a struggle it could have been if we had not had the long-established foundation of close teamwork to build on. No wonder the writers of political science textbooks point to the federal highway

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Webster St. Tube

Work Starts on New Facility Under Estuary

By P. E. PARKER, Senior Bridge Engineer and
H. J. WHITLOCK, Senior Electrical Engineer

Construction of the new underwater tunnel between Oakland and Alameda is now under way. The Contractors are Pomeroy-Bates & Rogers-Gerwick and the contract amount is $16,641,000. Work began on October 12, 1959, and is expected to extend over a three-year period. George A. Greene is the resident engineer.

This tunnel, now known as the Webster Street Tube, will be roughly parallel to, and about 500 feet westerly of, the existing Posey Tube.

When completed, the new tube will carry two lanes of one-way traffic to Alameda and the two lane Posey Tube will become one way to Oakland.

Both tubes will be operated as one unit and all operating controls for both tubes will be housed in the Oakland Portal Building of the Posey Tube.

The project consists of the construction of "boat section" approaches in both Alameda and Oakland, a "portal building" at each end of the tunnel for ventilating and electrical equipment, 12 precast tube segments each 300 feet long, a cast-in-place portion of tunnel 783 feet long, temporary bridges, a permanent bridge, waterfront and street work together with mechanical and electrical work and equipment. There are 153 items of work in the contract.



Retouched aerial photograph of project site. Dotted line on left shows location of Webster Street Tube. Existing Posey Tube is indicated by dotted line on right.

Old Method Described

Prior to the Posey Tube, which was completed in 1928, nearly all underwater vehicular tunnels were constructed using the "shield" method which involved underground tunneling and use of compressed air. The Posey Tube was constructed by sinking precast tunnel segments in a dredged trench, aligning them accurately and connecting them underwater. This so-called "trench" system proved to be so much more economical, that since that time, this method has been used whenever practicable.

In general the "trench" type of construction is feasible if:

(a) Cost of R/W for approaches is relatively low.
(b) Water is reasonably quiet to permit accurate landing of tunnel segments.
(c) Material within the project limits can be readily excavated without necessity of underwater blasting.
(d) Sufficient water depth exists to permit floating of segments.

The precast segments are circular in cross section, have an outside diameter of 37 feet, are 200 feet long and have a shell thickness of 2'-6". They are constructed entirely of reinforced concrete.

Segments Are Precast

It is understood that the contractor will construct the 12 precast segments two at a time in a basin which he will construct on the Alameda side of the Estuary about a mile from the tunnel site. Temporary watertight bulkheads will be placed in the ends of these segments to permit them to be floated. The scheme is to construct a segment, float it out of the basin, replace the head gate or dam, pump out the basin and construct the next segment.

The specifications have been written to ensure that the concrete for the

tube will be as watertight as possible. In addition, the exterior of the tube shell will be covered with membrane waterproofing. The waterproofing for the precast segments will be covered with timber lagging to protect them during the floating and placing operations.

Segment draft, buoyancy and stability must be carefully considered for all phases of the work. The weight of the tube shell, roadway slab and temporary bulkheads as constructed in drydock is approximately 5,500 tons and the buoyancy is approximately 7,100 tons. When floated, the segment will have a draft of approximately 30 feet. In order to sink a segment at the site it will be necessary to add at least 1,600 tons of ballast. This can be done by filling the space beneath the roadway slab with water and placing sand on the roadway slab. In addition, enough extra ballast must be added to ensure that the segment will stay in position when sunk. Segments of this size are very sensitive to changes in specific gravity of the water. A change, for example, from 1.00 to 1.02 would increase the buoyancy by nearly 150 tons. Such a change could be easily caused by muddiness resulting from the placing operation.

Masts Show Location

Alignment masts will be erected at each end of each precast segment. These masts will project above the water when the segment is in final position and permit its exact location to be known at all times by usual survey methods.

Divers working in depths of water up to 90 feet with attendant muddiness must rely to a great extent on sense of touch only. For this reason, the method of connecting the precast segments has been made as automatic as possible. It is planned to rest one end of each segment on the preceding one. The other end will rest on piles previously placed to exact line and grade. Thus the divers need only be sure that each section is landed properly. The final few feet of lowering of the section forces a rubber sealing ring around a tapered projection which makes possible the complete encasement of the joint with tremie concrete.

After the segment is placed in position, sand backfill is placed under and around it to a level at least seven feet above the bottom of the barrel. This sand is thoroughly compacted by jetting, sluicing or other means. Additional ballast is then added to the segment until the downward force is at least 600 tons. The piles supporting the segment initially are designed to fail under this downward force thereby transferring the loading to the sand bed.

Placing of Segments

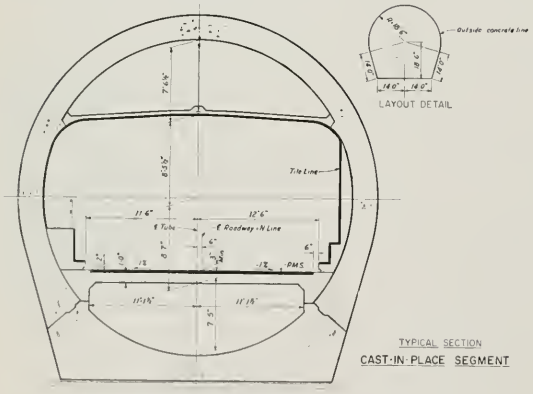
Placing of precast tube segments will begin at the Alameda Portal Building and continue across the Estuary to Oakland. The cast-in-place portion of the tube will be completed after all precast sections are in place.

The tunnel interior will be completed by entering one end, removing temporary bulkheads and pumping out ballast water and water trapped between bulkheads at each joint.

In addition to the rubber seal and tremie concrete seal at each joint there is a grout seal and a seal obtaining by welding a continuous steel plate across the joint.

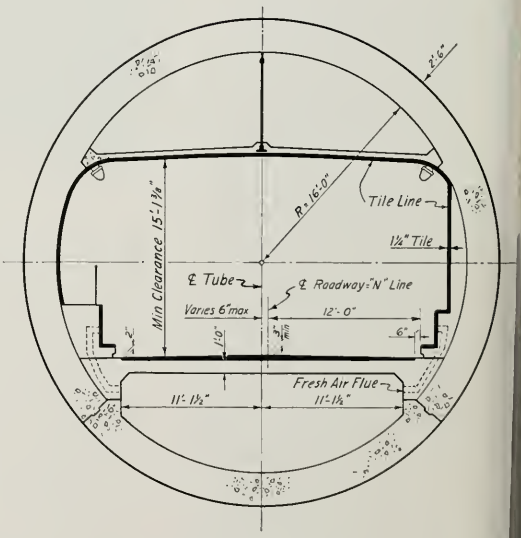
The tube will have a 24-foot roadway, a minimum vertical clearance of 15 feet 1⅜ inches, tiled ceiling and walls down to the roadway level and two lines of continuous fluorescent lighting. A PMS roadway surface has been specified to help reduce th

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TYPICAL SECTION
CAST-IN-PLACE SEGMENT

Horseshoe-shaped section is used to simplify placing of forms and concrete for portion of tunnel constructed in place in open trench.



TYPICAL SECTION
PRECAST TUBE SEGMENT

Circular section is used for the 12 precast tube segments for maximum buoyancy.

Freeways in District IV

By J. P. SINCLAIR, Assistant State Highway Engineer

THE "FABULOUS FIFTIES" have rought great advancements in modrn freeway construction in the San rancisco Bay area. During the decde, a total of 300 miles of freeway ave been completed in the nine ounties comprisng District IV.



J. P. SINCLAIR

However, the ifties have also een a tremendous rowth in popula- on and vehicle egistration. In 950, the nine ounties had a population of 2,643,000 ith 1,102,000 vehicles. At the end of 959, the population had grown to 648,000, an increase of over a mil- on people. Vehicle registration has ourted to 1,786,000. Traffic throughut the district has nearly doubled.

Some of the comparative average daily vehicle counts are as follows:

Location	*Number of Vehicles 1950*	*1960*
Eastshore (Ashby Avenue)	46,000	83,000
S.F.-Oakland Bay Bridge	80,000	104,000
Golden Gate Bridge	26,000	50,000
Bayshore (South San Francisco)	29,000	75,000
US 50 (Dublin)	8,000	17,000

The total expenditures on freeways in District IV in the last 10 years is approximately $600,000,000. The district's total construction and right-of-way budget was $19,000,000 in 1950 and has increased to $80,000,000 this past year. This is a measure of the acceleration in the freeway program.

During this 10-year period, the Nimitz Freeway from Oakland to San Jose has been completed.

Sign Route 17 Freeway from San Jose to Los Gatos will be finished this summer.

US 40, the interstate route from the Bay Bridge to Carquinez, is all full freeway except the one link from El Cerrito Overhead to Richmond, which is under construction and scheduled for completion this spring.

The last unit of the freeway on Sign Route 24 between Orinda and the Monument will be completed this spring while the project east of Orinda through Charles Hill to the Lafayette Bypass was opened to traffic last November.

This year, the last two projects to make the Bayshore a continuous freeway from San Jose to San Francisco are being advertised.

US 101 north of the Golden Gate Bridge is a divided highway through Santa Rosa, with the section to San Rafael completed as a full freeway last summer. Design is under way for converting the expressway to full freeway from San Rafael to Petaluma, and the first construction project at Freitas Parkway has commenced. Other projects are being constructed or budgeted for a full freeway on the Healdsburg Bypass and a section from Santa Rosa to Windsor. Planning activities have

oto below—Ground view of the Walnut Creek " Interchange. Branch connection structure from SSR 24 to SSR 21 in immediate foreground.



resulted in the adoption of the last unit of a freeway route north of Lytton which provides a freeway location all the way from San Francisco to the Mendocino county line.

Design work has started on the Junipero Serra Freeway, an interstate route from San Bruno to San Jose, and three fourths of the cities have signed freeway agreements. Routes have been determined for all other sections of the interstate system in the district except the portion in San Francisco and Daly City. Planning activities have started on several of the new freeway locations designated in Senate Bill No. 480.

A more detailed review of construction highlights and future plans for freeway development in District IV follows:

US 40—San Francisco to Corquinez Bridge

A 2.3-mile project presently under construction between south of El Cerrito Overhead and Jefferson Avenue is the last link of freeway on US 40 between San Francisco and Vallejo. Estimated to cost approximately $5,583,000, it is being performed as a joint venture by Piombo Construction Company, M&K Corporation and Connolly Pacific Company. Completion in June of this year is anticipated for this six-lane freeway project which includes three interchanges: a direct connection at Hoffman Boulevard to State Sign Route 17, and diamonds at Central Avenue and Carlson Boulevard. A more detailed account of this project will appear in the May-June issue of *California Highways and Public Works*.

An eight-lane freeway is already in operation from the distribution structure at the east end of the San Francisco-Oakland Bay Bridge to the El Cerrito Overhead. Also previously completed is a six-lane freeway to the Carquinez Bridge which included the eight and one-half million cubic yard "Big Cut" which is approximately 0.6 mile long, a quarter mile wide at the top, and 300 feet deep. Three contracts completed the approaches to and erection of the parallel Carquinez Bridge, opened to traffic in November 1958.

Temporary connections were provided at each end of the new bridge to permit two-way traffic so that the old bridge could be modified and the Crockett approach ramp could be constructed. This project, costing approximately $1,315,000, was completed in April of 1959 and provides for three lanes of southbound traffic on the old bridge and four lanes northbound on the new. Rothschild, Raffin and Weirick performed this work.

Construction of US 40 north of Arnold Industrial Highway (State Sign Route 4) was financed from revenue bonds as part of the Carquinez Bridge project. Another major US 40 project being financed by toll bridge funds is the reconstruction of the approach ramps to the double-decked Bay Bridge so that five lanes of one-way westbound traffic will be carried on the upper level with eastbound traffic on the lower deck. This work is being administered by the Division of San Francisco Bay Toll Crossings. Toll bridge funds also provide for the widening of the south side of the Bay Bridge Toll Plaza. This work, expected to start shortly, will be done in conjunction with remodeling and increasing the number of the toll booths. Faster collection for Oakland-bound traffic will be made from the driver's side of the vehicle and truck tolls by weight will be superseded by axle count tolls to save time.

During 1959, landscaping was completed on the constructed portions of the freeway south of El Cerrito Overhead and north of San Pablo Avenue to Ridge Road. Funds in the amount of $280,000 have been provided in the 1960-61 fiscal year budget for landscaping between 0.3 mile south of El Cerrito Overhead to 0.3 mile south of Jefferson Avenue which will be advertised for bids this spring. An additional $130,000 has been provided for landscaping on which work is now starting from the Port of Oakland Overhead on the San Francisco-Oakland Bay Bridge approaches to the distribution structure. A small planting project is underway between Ridge Road and Crockett.

US 50—Bay Bridge to Castro Valley

Work has started on the first unit of the MacArthur Freeway which will ultimately provide an eight-lane interstate facility from the Bay Bridge Distribution Structure in Oakland to Castro Valley. A total of $23,000,000 has been included in the 1959-60 and the 1960-61 budgets for the construction of four projects comprising the 3.9-mile section between the distribution structure and 14th Avenue in Oakland. Right-of-way is nearly all acquired.

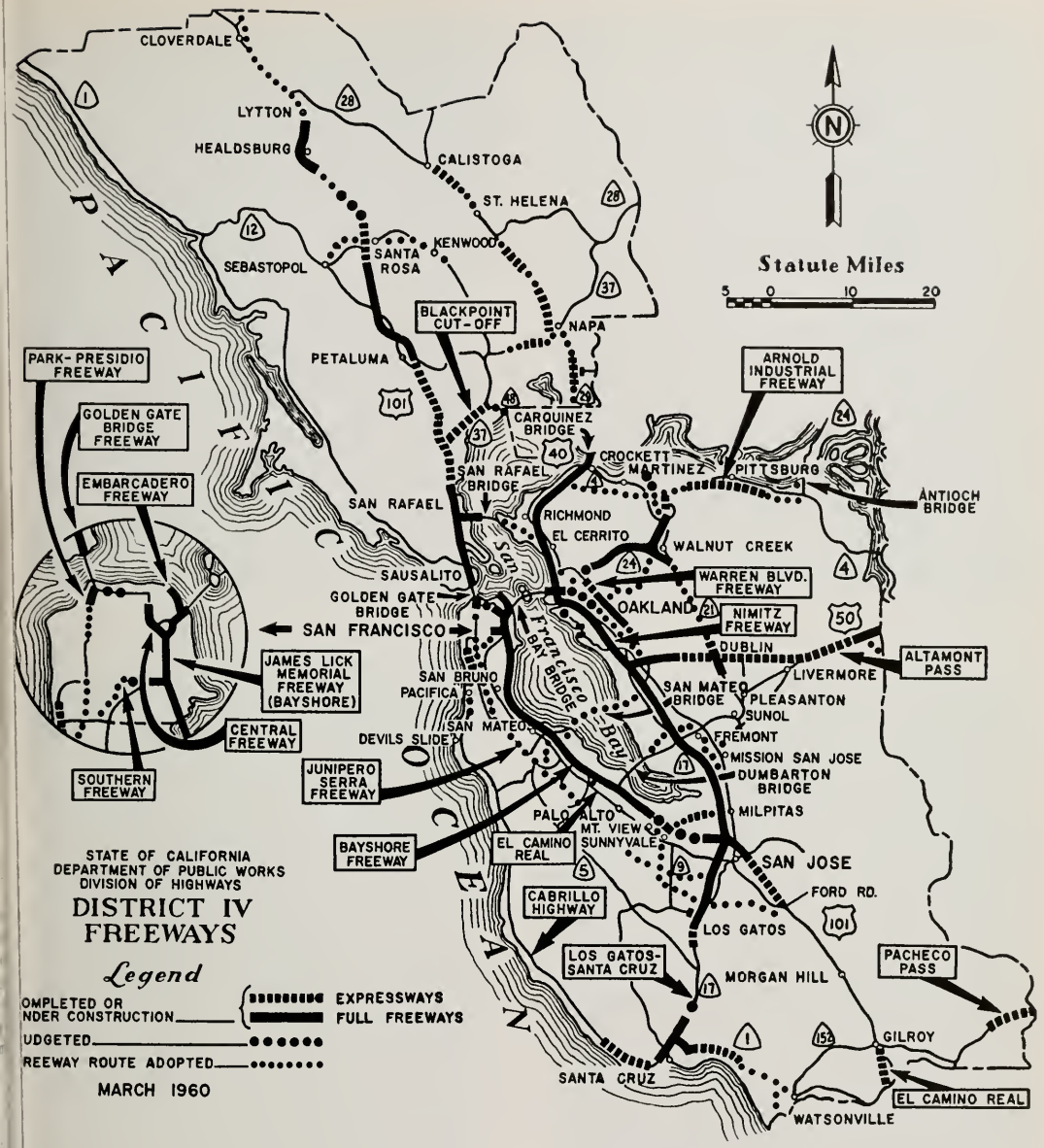
The usual design problems occasioned by intersecting freeways have been further complicated at the intersection of the MacArthur and Grove-Shafter Freeways by the recently proposed inclusion of the rapid transit facilities in the Grove-Shafter median. Studies by the Bay Area Rapid Transit Commission are not yet complete, nor is financing certain. However, bridge superstructures will be deferred and construction staged so that the much-needed MacArthur projects will get underway on schedule and will include all features necessary to the proper handling of US 50 traffic. These alterations will avoid extensive revisions to accommodate possible rapid transit requirements in the Grove-Shafter Freeway.

A more detailed article covering the planning, design and right-of-way aspects of the MacArthur Freeway, as well as the limits and funds of budgeted projects, is contained elsewhere in this issue.

US 50—Castro Valley to San Joaquin County Line

Portions of the Nimitz Freeway (State Sign Route 17), Route 228 easterly to Castro Valley and US 50 easterly have provided a continuous freeway from Oakland to Dublin, since the 1957 completion of a four-lane facility between Castro Valley and 2.3 miles west of Dublin. To the east of Dublin, US 50 is presently an expressway with a controlled number of intersections at grade.

Construction activities in this area during the past year have been limited to landscaping, resurfacing, and minor projects. Among these is a landscaping project to be completed soon between Center Street in Castro Valley and the Nimitz Freeway, and a seven-mile resurfacing project east of Livermore which was completed in July of 1959. The latter work was



one by A. Teichert and Son at a cost of $135,400.

Studies have continued for the development of the existing expressway east of Dublin to full freeway standards. Aerial mapping is underway for preparation of plans for an initial six-lane, ultimate eight-lane freeway between Dublin and Greenville. Planning studies are being made on the portion of this route between Greenville and 1.5 miles east of the Alameda-San Joaquin County Line to meet Federal Interstate requirements.

US 101—Golden Gate Bridge to San Rafael

The year 1959 saw continued progress towards the development of a full

freeway on the Redwood Highway (US 101) north of the Golden Gate Bridge.

Prior construction provided a six-lane freeway from the bridge to Greenbrae. A northbound freeway structure and ramps at the Greenbrae Interchange were completed last October at a cost of $1,780,000.

Bids on the final stage of construction at Greenbrae Interchange are scheduled to be opened late in April. It is estimated to cost approximately $1,240,000 and will create a three level separation providing both left and right turn ramps for northbound freeway traffic. The old bridge with a lift span across Corte Madera Creek will be removed.

Previous projects northerly completed a six-lane freeway to the San Rafael Viaduct.

Funds in the amount of $54,500 were provided in the 1959-60 budget for landscaping US 101 between the Richardson Bay Bridge and Corte Madera Creek. This work which includes the planting of redwood trees is presently underway.

Studies are now in progress for expansion to an eight-lane freeway from San Quentin Wye to Porto Suello Hill, north of San Rafael, including expansion of the present four-lane San Rafael Viaduct.

US 101—San Rafael to Petaluma

This section had been previously developed as an expressway with intersections at grade. The first project to convert to six-lane full freeway standards at the Freitas Parkway intersection was awarded to Frederickson and Watson Construction Company. The $1,250,000 contract scheduled for completion in November includes a trumpet type interchange, frontage roads and a partial interchange at San Pedro Road near the new Marin County Civic Center.

Design studies are proceeding on a six-lane, freeway from 0.6 mile north of Forbes Overhead to north of Atherton Avenue in Novato. Future construction projects will include a partial interchange at Miller Creek Road, an added northbound uphill lane to relieve congestion on a sustained grade, and an interchange at Ignacio Wye at the intersection of US 101 and State Sign Route 37 as soon as construction funds are made available.

US 101—Petaluma to Mendocino County Line

An 18.5-mile section of freeway from south of Petaluma to the southerly city limits of Santa Rosa was completed in 1957 after a series of five construction projects. Design studies are underway for a $3,000,000 conversion of the existing expressway through the City of Santa Rosa to the initial four lanes of an ultimate six-lane freeway.

Funds have been provided in the 1960-61 construction program for a 9.2-mile four-lane freeway northerly from Mendocino Avenue in Santa Rosa to Grant Creek. This $5,200,000 project which includes five interchanges, provides for construction of the freeway between Santa Rosa and Windsor and for grading between Windsor and Grant Creek. Design is nearly completed for drainage, bridges, base and surfacing on the latter portion although this estimated $3,800,000 project has not yet been budgeted for construction.

North of Grant School, a 1.2-mile portion of the Healdsburg Bypass south of the city was completed in May of 1959. This $1,629,000 project also included twin bridges over the Russian River, partial construction of interchanges at Grant Avenue and South Healdsburg, and accomplished 3.7 miles of rough grading for the freeway to the north.

The current phase of construction which will complete the bypass to a connection with the existing highway at Lytton was awarded to Guy F. Atkinson. This 4.1-mile $2,700,000 project includes interchanges at Dry Creek and Guerneville Roads as well as three other bridges and undercrossings. It is expected that construction will be completed late this summer.

From Lytton to Mendocino county line, the route has been adopted and a four-lane expressway providing for development to a six-lane freeway is being designed.

Planting of redwood trees on portions of the freeway between the Petaluma Creek Bridge and Santa Rosa was accomplished last year. This work, costing approximately $14,500, was performed by Shawn Company.

The 1960-61 construction program provides $100,000 for landscaping on 0.8-mile portion of the freeway between Lynch Creek and the south city limits of Petaluma. Bids will probably be advertised this summer.

US 101 (Bypass)—San Francisco to Palo Alto

Previous projects on the Bayshore have provided a continuous six-lane freeway from the south city limits of San Francisco to Palo Alto, a total distance of 26 miles. Included in these projects were four contracts totaling $7,710,000 for the "open water fill" across an arm of the San Francisco Bay, between Sierra Point and Candlestick Point. This section saved 0.4-mile distance and reduced commute hour travel time by approximately 20 minutes.

Heavy, congested traffic on this freeway near the San Francisco International Airport led to the inclusion of $1,900,000 in the 1959-60 budget for widening the freeway to eight lanes from Broadway in Burlingame to San Bruno Avenue in San Bruno. This 7.5-mile project, to be advertised this spring, will include the addition of a direct right-turn ramp to the southbound freeway lanes and improvement of other ramp outlets at the Millbrae Avenue Interchange. An additional northbound lane is included between Broadway and Peninsular Avenue. A double metal beam barrier will be provided between the opposing traffic lanes through these areas.

Improvements north of Palo Alto during the past year have included landscaping and minor interchange revision. A 2.2-mile, $82,000 landscaping project between Peninsular Avenue and 16th Avenue in San Mateo was completed in April of 1959, and consisted of planting trees, shrubs, and ground cover. Also completed in April was the Norfolk Street connection to the East Hillsdale Boulevard Interchange at a cost of approximately $59,700.

Presently under way is a $220,000 landscaping project at Willow Road and University Avenue Interchanges. Included in the 1960-61 budget is $180,000 for landscaping the completed freeway between 16th Avenue in San Mateo and Harbor Boulevard



Greenbrea Interchange in Morin County on US 101 at Corte Madera Creek, looking south. Corte Madera Interchange structure in upper left background.



Looking southeast along US 101 in San Rafael. San Quentin Wye Overcrossing connection to Sign Route 17 Freeway and Richmand-San Rafael Bridge in upper portion. US 101 curves to right at overcrossing.



Yountville Byposs project on SSR 29 in Napa County. Looking northwesterly from the beginning of project, California Drive Interchange in center.



Atherton Avenue Interchange at Black Point an SSR 37, looking east. Petaluma Creek Bridge at upper left.



Looking southwest over the Crockett Interchange from the Carquinez Bridge, through the "big cut."

US 101 (Bypass)—Palo Alto to San Jose

Funds in the 1959-60 and 1960-61 budgets provide for construction of the last two links in the continuous Bayshore Freeway between San Francisco and San Jose. Several other contracts are currently under way and an important interchange was completed this past year.

The interchange at the intersection of Bayshore Freeway and Sign Route 9 was completed in July. This $1,257,000 project, including an overpass carrying Mountain View-Alviso traffic over the Bayshore and short sections of six- and four-lane freeway, was constructed by Dan Caputo and M.J.B. Construction Company as a joint venture.

Virtually completed is the 4.4-mile freeway extension from the San Mateo county line to Stierlin Road. This six-lane facilitiy is being constructed by L. C. Smith and Concar Ranch and Enterprises at a cost of approximately $3,465,000. It will provide interchanges at Embarcadero and San Antonio Roads and a partial interchange at Middlefield Road.

In San Jose a 4.1-mile freeway section from Brokaw Road to Taylor Street is under construction. This project includes four interchanges and a total of 13 structures. A major interchange is provided at the intersection of Nimitz, Bayshore and Sign Route 17 Freeways. Also included in this $4,315,000 project is the extension of State Sign Route 17 as a freeway to First Street in San Jose.

One of the two remaining gaps in the freeway is scheduled for advertisement this spring and will extend Bayshore Freeway from Charleston Road in Mountain View to the Guadalupe River near San Jose. This $5,050,000 project also includes work on the Mountain View-Alviso Road (State Sign Route 9) from Bayshore to 0.2 mile east of Borregas Avenue. Another feature is the alteration of existing channel facilities of the Santa Clara County Flood Control District including the Guadalupe River realignment. The Flood Control District is participating in the cost of the project.

The last remaining section of the freeway between Brokaw Road in San Jose and Morse Avenue in Sunnyvale is included in the 1960-61 budget. This 6.1-mile project will consist of a four-lane facility between Brokaw Road and Guadalupe Parkway, and six lanes from there to Morse Avenue. Cloverleaf interchanges will be provided at Fair Oaks Avenue, Lawrence Station Road, San Tomas Aquinas Boulevard and De La Cruz Boulevard. This project will complete the freeway between San Francisco and San Jose, costing approximately $5,760,000, and it is expected to be advertised this spring.

US 101 (Bypass)—San Jose to US 101 at Ford Road

Design studies are underway for conversion of the existing expressway to freeway standards from Santa Clara Street to Ford Road. The expressway has been in operation since 1947.

North of Santa Clara Street the last three-lane portion of this route was eliminated in 1957 by the completion of 1.3 miles of freeway to north of Taylor Street in San Jose.

Funds in the amount of $100,000 are in the 1960-61 budget for landscaping this section.

US 101—Ford Road to San Benito County Line

Studies have been completed and a public meeting will be held in the near future on the proposed freeway routing between Ford Road and south of Gilroy. These studies are the culmination of several years of work by the division and the Santa Clara County Planning Department.

South of Gilroy, 5.8 miles of expressway have been in operation to the San Benito county line since 1951. Full freeway development within these limits is dependent upon traffic requirements and availability of funds.

A $119,200 resurfacing project between Llagas Creek and Gilroy was completed in August. Drainage improvements were constructed in Morgan Hill as a co-operative project with that city.

US 101—El Camino Real

Although not a freeway, this historic route plays an important role in serving the communities of the Peninsula between San Jose and San Francisco. Major portions have been and are being widened to four and six lanes with some median separation. In co-operation with the many cities, traffic signal and channelization projects have been completed and others are being planned.

A $1,345,000 project was completed in 1959 which provided 3.9 miles of divided highway between San Tomas Aquinas Creek in Santa Clara and State Sign Route 9 in Sunnyvale. The Santa Clara County Flood Control District participated.

Design studies are underway for widening El Camino Real to a six-



Bayshore Freeway along peninsula south of San Francisco. Willow Road Interchange in Palo Alto in center foreground with University Avenue Overcrossing in upper left; looking south.



Looking westerly across the University Avenue Interchange on Bayshore Freeway in the City of Palo Alto.



Looking southerly at the site of construction for interchange facilities between Sign Route 17 and US 101 Bypass (Bayshore) near San Jose. Old Boyshare Highway Intersection in foreground, new Nimitz-Bayshare Interchange in center.

lane divided highway between Taylor Boulevard in Millbrae and Old Mission Road in Colma. Similar projects are being studied in Palo Alto between University Avenue and Matadero Creek, and a four-lane divided arterial is under design study between Ford Road and South Tully Road.

The widening to an ultimate six-lane divided section of the portion of El Camino Real between Palo Alto and San Jose is under study, and public hearings have recently been held to discuss the plan.

US 101 in San Francisco

Nearing completion is the first unit of the Southern Freeway. This construction will provide a direct connection interchange for the intersection of the Southern and James Lick Memorial Freeways at Alemany Boulevard. In addition to the interchange connections, the project required relocation of Bayshore Boulevard, reconstruction of ramp facilities at the Alemany Boulevard interchange on James Lick Memorial Freeway, and rough grading for a portion of the eight-lane Southern Freeway. This work by the Guy F. Atkinson Company scheduled for completion this spring will cost approximately $8,100,000, and of this amount, $1,450,000 has been contributed by the City of San Francisco.

To be advertised probably this summer is the second unit of this freeway, for which $4,995,000 has been included in the 1959-60 budget. This 1.4-mile project provides for building six lanes of the ultimate eight-lane freeway from the James Lick Memorial interchange westerly to Milton Avenue.

Design studies for the next 1.3-mile portion between Ocean Avenue and Mission Street are well advanced. Right-of-way acquisition is nearly completed and $6,000,000 has been provided in the 1960-61 budget for construction. The route for the Southern Freeway has been adopted as far as Orizaba Avenue near the south city limits of San Francisco.

The full value of the Southern Freeway will be greatly enhanced when its extension easterly and northerly to the Embarcadero Freeway is completed. This connection was added to the State Highway System in 1959 as Route 253. A section has been adopted and construction may proceed as soon as right-of-way is acquired by the city under terms of the legislative act adding this new route to the system.

James Lick Memorial Freeway (US 101)

A six- and eight-lane freeway has been in service since 1956 from the county line near Third Street to the San Francisco-Oakland Bay Bridge. This skyway is used by approximately 125,000 vehicles daily and affords motorists a panoramic view of San Francisco. Work in the past few years, except for the revisions necessitated by construction of the direct connections to the Southern Freeway, has consisted of landscaping, erosion control, and installation of barriers to prevent disastrous median crossing accidents.

The Chicago Fence and Equipment Company is presently constructing a median barrier on portions of the section between south of Third Street and Army Street. This 1.4-mile installation consists of back-to-back steel guard rails and will cost approximately $74,000. It extends the barrier completed in 1958 between 17th Street and Army Street. Since the first installation, there have been no median crossing accidents and the number and severity of all accidents in this area have declined noticeably.

The gap left in the present barrier contract, within the limits of the interchange project now under way, will be closed by a separate contract.

A landscaping project between Fifth Street and 17th Street was completed during the past year by Watkins and Sibbald at a cost of $38,000.

Central Freeway

In April of 1959, the second unit of this distributor facility to the Civic Center area of San Francisco was opened to traffic. It extends the elevated six-lane section of divided freeway between the James Lick Memorial Freeway and South Van Ness Avenue by means of a two-level elevated structure to Turk Street.

The extension provides off ramps to the intersections of Fell and Laguna Streets and to Franklin and Golden Gate. On ramps were provided for traffic from Oak and Laguna and Turk and Gough. The viaduct, carrying southbound traffic on the upper

deck and northbound traffic on the lower deck, leaves the city streets below free to handle the heavy cross-traffic movements. The contractor on this $7,800,000 project was Peter Kiewit Sons' Company.

Approximately $450,000 has been provided in the 1960-61 budget for landscaping and paving parking areas along the Central and James Lick Memorial Freeways. Presently there are two such projects in progress; a $46,000 contract being performed at nine locations on the Central, James Lick and Embarcadero Freeways by Charles L. Harney, Inc., and a $72,000 project for paving parking lots between Mission Street and Turk Street. The contractor on the latter project is O. C. Jones and Sons.

Embarcadero Freeway

This 1.5-mile elevated facility providing traffic service from the Bay Bridge and James Lick Memorial Freeway was constructed in three projects starting in April of 1955. The last project was completed in March of 1959 at a cost of approximately $7,627,000 for 1.2 miles of double-deck elevated viaduct. Ramps were provided at Broadway. Extensive reconstruction work was required to relocate portions of the Southern Pacific Railroad and State Belt tracks under the freeway along the Embarcadero. A $12,000 landscaping project between Front and Sansome Streets is underway.

Studies are now underway for the location of Route 253 which was added to the state highway system by the 1959 Session of the Legislature. This will provide an extension of the Embarcadero Freeway southerly to the vicinity of Army Street and thence westerly to a connection with the Southern Freeway at James Lick Memorial Freeway. A Hunter's Point leg connecting near Army Street will extend southerly to the Bayshore Freeway near the south city limits. Public meetings will be held upon completion of the studies.

Sign Route 17

This highway links the metropolitan communities of the Bay area with the recreational facilities of the Santa Cruz area. Two projects presently under construction, estimated for July completion, will provide 75 miles of continuous freeway via Sign Route 17 from south of Los Gatos to Oakland, thence along US 40 to Vallejo.



Looking east along Sign Route 24 toward Mt. Diablo with Acalanes Valley Road Interchange in foreground.

One of these projects, two and one-half miles of initial four-lane, ultimate six-lane freeway, is being constructed between Bascom Avenue and North Fourth Street in San Jose at a

cost of $3,117,000. This work, scheduled for completion in August, is being performed as a joint venture by Gordon H. Ball, Gordon H. Ball, Inc., Ball and Simpson, and Lew Jones Construction Company. Interchanges will be provided at Bascom Avenue, El Camino Real, Coleman Street, and North First Street. A separation structure at Laurel Street and a bridge over the Guadalupe River are also included. (The second project connecting this work with the Bayshore and Nimitz Freeways, also scheduled for completion in August, is discussed more fully under US 101 Bypass.)

Additional signal and minor contracts were completed during the past year and $175,000 has been provided in the 1960-61 budget for 5.5 miles of landscaping between Roberts Road and Danta Street.

North from the recently landscaped freeway entrance to the City of Santa Cruz, the freeway is being extended by 3.3 miles of four-lane expressway, to Carbonera Creek near Glen Canyon Road. This work, scheduled for completion in May being performed by Frederickson and Watson, is virtually complete. The $1,650,000 contract includes interchange facilities at Pasatiempo and an underpass structure at Beulah Park Drive. Frontage roads are provided along most of the expressway.

Immediately to the north, construction is starting on the 3-mile section from Glen Canyon Road to 0.6 mile north of Granite Creek Road. This $1,500,000 four-lane expressway includes interchanges at Granite Creek and Glen Canyon and an overcrossing at Scott Valley. The elimination of the three-lane highway through Scott Valley will provide a continuous freeway-expressway from Sign Route 1 in Santa Cruz to Santa's Village.

A major realignment along this route was completed in April 1959, when the 8.8-mile section of freeway between the junction of the Saratoga-Los Gatos Highway in Los Gatos and Bascom Avenue in San Jose was opened to traffic. This $5,835,000 project included 20 structures. Interchanges were provided at Saratoga Avenue, Lark Avenue, Camden Avenue, Hamilton Avenue, Stevens Creek Road, and Bascom Avenue.

A landscaping project at the Saratoga Avenue Interchange in Los Gatos is being completed at a cost of $49,000. Planting on the remainder of the freeway between Los Gatos and Bascom was completed in January, costing $87,500.

San Jose to Oakland (Nimitz Freeway)

Although the last gap in the continuous freeway between San Jose and Oakland was completed in 1958, planning continues on this important arterial. It was originally constructed as a four-lane freeway from San Jose



Central Freeway in San Francisco, looking southeast from Turk Street and Gough Street terminus. City Hall at extreme left center facing the Civic Center Opera House and Veterans Memorial Buildings. Ramps to Oak and Fell Street at right center.



James Lick Memorial (Bayshare) Freeway in San Francisco at the site of construction for the Southern Freeway Interchange. Alemany Interchange in foreground; looking south.

to High Street in Oakland, but increased flows of traffic have indicated the need for additional lanes. The first such widening project was completed in 1956 between Washington Avenue in San Leandro and High Street in Oakland to handle the increased traffic resulting from completion of the four-lane freeway between US 50 and the Nimitz Freeway.

Funds in the amount of $4,800,000 have been provided in the 1960-61 budget for additional widening to eight lanes between Hegenberger Road and Fallon Street in Oakland and will be advertised this summer. This 5.6-mile project will include median barrier installation from High Street to Fallon Street. Studies for an additional two lanes of widening to provide an eight-lane freeway as far south as Route 228 in San Leandro are proceeding and a six-lane facility from there to Route 105 in Hayward are under way.

Funds have been provided in the 1959-60 budget for construction of the Floresta Drive Overcrossing over Nimitz Freeway in San Leandro which will be advertised for kids this spring. Jointly financed by the City of San Leandro, this project will cost $283,000, of which $160,000 is being provided by the State.

Presently under construction is 6.8 miles of median barrier installation between Washington Avenue and High Street at a cost of $214,000. Chain-link



A view northerly along Sign Route 24 at the Oak Park Boulevard Interchange. Hookston Road Interchange in background.

fence and cable barrier is being installed on the southerly portion of the project to 98th Avenue in Oakland, while blocked-out guard rail is being placed from 98th Avenue to High Street. In November, a 2.1-mile landscaping project costing $84,000, between Tennyson Road and Jackson Street, was completed. Also, a $56,800 landscaping project was completed in August 1959 from the distribution structure to north of Market Street. Thirty-five thousand dollars has been included in the 1960-61 budget for the 1.5-mile landscaping project between Fifth Avenue Overhead and Linden Street.

US 40 to US 101 (Sign Route 17)

Design studies are under way for the construction of a six-lane freeway between El Cerrito Overhead and 32d Street in Richmond with provisions for a future eight lanes between 32d Street and Marine Street, at the east end of the Richmond-San Rafael Bridge. This 5.8-mile section is estimated to cost $11,850,000 and is not yet programed for construction. In the interim, as in the past, numerous projects including drainage improvements and channelizations of various intersections along Hoffman Boulevard have been completed to allow more efficient use of the existing facilities. One such project is presently under construction at the intersection of Hoffman Boulevard and 47th Street in Richmond. The work, including traffic signals, highway lighting and channelization, is being performed by Lee J. Immel and will cost approximately $88,800.

A western approach from US 101 in Marin County to the Richmond-San Rafael Bridge was constructed to freeway standards in two projects. The first contract was between Tiburon Street and Point San Quentin. The other unit was completed in August of last year and provides continuous freeway between US 101 and the bridge. This two-mile freeway section cost $767,000. Financing for these approaches was provided by Division of Highways funds while the San Rafael-Richmond Bridge and its eastern approaches were constructed through bonds issued by the Division of Bay Toll Crossings.

Sign Route 21—Warm Springs to Dublin

From Warm Springs to two miles north of Mission San Jose, this portion of the interstate route location lies to the west of existing state highway. North of Mission San Jose, the route has been adopted generally along the existing route with substantial reductions in the grade rate over Mission Pass. Design studies are under way for a freeway on both of these portions which will complete the facility to Sunol. North of Sunol to the intersection with US 50 to Dublin, public meetings and a Highway Commission hearing have been held and it is expected that a route will be adopted shortly on this 11.1-mile portion.

Sign Route 21—Dublin to Martinez

The initial two lanes of the future freeway between US 50 and the Contra Costa county line, a distance of 1.8 miles, was constructed in 1955. Included in this work was the interchange with US 50.

North of the county line to Walnut Creek, design studies are well advanced for the two projects comprising this 12.2 miles of freeway facility. Rights-of-way are being acquired for an initial four-lane, ultimate six-lane freeway which is expected to cost approximately $15,000,000.

In the vicinity of Walnut Creek, an $8,546,000 contract is nearing completion for construction of a 4.2-mile four- and six-lane facility between Rudgear Road and the junction with Sign Route 24 near Oakland Boulevard. This contract also includes the portion of State Sign Route 24 from the completed freeway near Lafayette to Walnut Creek. Sixteen major structures and five major interchanges are included in this contract which was started in June of 1957. The work is being performed by Charles L. Harney.

North of Oakland Boulevard, a 2.9-mile section of freeway to Monument has been in operation since January of 1957. The route for the future freeway between Monument and the Martinez-Benicia Bridge has been adopted. Financing of this facility to Escobar Street in Martinez will be from federal and state participation in the interstate program. Construction northerly of this point, including the bridge itself, will be financed through revenue bonds in conjunction with the toll bridge project authorized by the Leg-

islature in 1952. The bridge is presently under construction and is expected to be completed in the summer of 1962. A high level structure, west of the existing Southern Pacific Railroad Bridge, will cost approximately $14,240,000. To be advertised this summer are the approaches between the bridge and Arnold Industrial Highway (State Sign Route 4).

Funds in the amount of $350,000 have been provided in the 1960-61 Budget for landscaping the project presently under construction near Walnut Creek.

Sign Route 24

Beginning at Ashby Avenue Interchange on US 40 (Eastshore Freeway) in Berkeley, Sign Route 24 proceeds easterly through the Broadway Tunnel to Walnut Creek, Concord, Antioch and northerly points via the Antioch Bridge.

$10,000,000 is provided in the 1960-61 budget for an additional two-lane bore to be constructed to the north of the two existing two-lane tunnels. Completion of this project for which bids will be advertised this summer will allow four-lane operation in one direction during peak hours and permit tunnel maintenance without restricting traffic flow during off peak hours. Easterly of the east portal to the completed freeway near Orinda, design is under way for an eight-lane freeway. This 1.6-mile section is expected to cost approximately $5,000,000.

Orindo to Arnold Industriol Freeway

East of the Orinda interchange which has been in service since 1955, a 2.1-mile project was recently completed. This $4,380,000 contract provides a six-lane freeway between Orinda Road to 0.8 miles east of Sunnybrook Drive. The work, performed as a joint venture by Gordon H. Ball, Gordon Ball, Inc. and Ball and Simpson includes a diamond interchange at Charles Hill Road and a four-quadrant cloverleaf at Acalanes Valley Road. It involved co-operative work with Contra Costa County and the Central Contra Costa Sanitary District.

This project connects to the Lafayette Bypass which was completed in 1957. Immediately to the east of the Bypass is the Pleasant Hill Interchange which serves as a connection between this major freeway and an important county expressway to the north; it will in the future provide a southerly connection to Oakland via the Shepherd Canyon Freeway. The remaining portions of freeway required to provide a continuous freeway from west of Orinda to north of Monument near Concord are under construction and has been discussed under Sign Route 21.

Watkin and Sibbald are the contractors on a $28,700 landscaping project between Sunnybrook Drive and Hodges Road which should be completed shortly. $125,000 has been provided in the 1960-61 budget for landscaping the project between Orinda Road and Sunnybrook Drive. Additional funds are provided in the same budget for landscaping the remaining portion near Walnut Creek.

Concord to the Sacramento County Line

Between the westerly portion north of Concord and Neroly Road east of Antioch, Sign Routes 24 and 4 are identical. A major portion of the route between Willow Pass Road and A Street was completed to freeway standards in 1952. South of Sign Route 4 to Concord and north of A Street in Antioch to the bridge, the route has been adopted and design studies are in an advanced stage.

Junipero Serra Freeway

From San Bruno Avenue north to its present intersection with Sign Route 1 in Daly City, the existing Junipero Serra expressway is known as State Highway Route 237. Constructed by Joint Highway District 10, it was taken into the state highway system when that district was dissolved in July of 1956. In this area, numerous studies have been made in connection with the development of other freeways in the vicinity for pos-



Looking north along Sign Route 17 Freeway at Stevens Creek Road Interchange in San Jose. Boscom Avenue Interchange at upper right.

sible relocation between San Bruno Avenue and the San Francisco county line. Public meetings were held in January 1960.

South of San Bruno Avenue this important interstate route was designated by the 1957 Legislature as State Highway Route 239. The route has now been entirely adopted between US 101 south of Ford Road in Santa Clara County to San Bruno Avenue in San Mateo County. Survey control and aerial mapping has been completed. Design studies are under way on over 50 miles of this facility. Including rights-of-way, the cost of the initial development is estimated to be approximately $74,000,000. Freeway agreements have been executed with most of the local governmental bodies and detailed designs are being made preparatory to right-of-way acquisition.

Sign Route 1

South of San Francisco, this facility is known as the Cabrillo Highway. The route has been adopted for a freeway bypass at Watsonville and preliminary project studies are well advanced for conversion to full freeway from Watsonville to Rob Roy Junction. North of Rob Roy Junction to Santa Cruz, an expressway has been in operation for several years and design studies are well advanced for development of this 6.5-mile section of full freeway.

In the vicinity of Santa Cruz, two projects have been completed to freeway standards. The most recent of these was the 2.1-mile freeway between the junction of Sign Route 17 and 0.3 mile east of Morrissey Avenue. This work was completed in November of 1958. Also completed about this time was the initial two lanes of a future four-lane expressway on new alignment between Swift Street in Santa Cruz and Wilder Creek. This project was jointly financed with Joint Highway District No. 9.

From Wilder Creek to 4.0 miles south of Davenport, a 3.1-mile section of expressway is under construction. Initially two lanes are being constructed with four lanes being built at locations where the terrain restricts sight distance. This work, expected to cost $940,000, is being jointly financed with Joint Highway District No. 9 which contributed $240,000. Also under construction is 2.1 miles between New Years Creek near the Santa Cruz county line and 0.2 mile south of Whitehouse Creek. This work involves reconstruction, realignment, and widening and completes the first-stage improvement financed jointly by the State and JHD No. 9. Since the district's organization in 1927, it has contributed approximately $3,883,000 to the improvement of the 68 miles of Sign Route 1 between Santa Cruz and San Francisco including the $240,000 being contributed to this $417,000 project. Funds in the amount of $150,000 have been provided in the 1960-61 budget for the base and surfacing of a portion of Sign Route 1 between San Gregorio Creek and one mile north of Tunitas Creek in San Mateo County.

Route studies are under way between Canada Verde Creek south of Half Moon Bay and Pedro Valley. Preliminary conferences have been held and geologic and materials studies are about complete for the portion covering the proposed relocation in the Devils Slide area. Public meetings are anticipated in the near future.

Between Pedro Creek and 0.4 mile north of Manor Drive, freeway design studies are under way. The portion north of Manor Drive was completed in 1958 as a four-lane expressway between Manor Drive and Skyline Boulevard in Daly City. Design studies are progressing for its development to a six-lane freeway with additional separation structures.

From Skyline Boulevard near Edgemar Road in Daly City, Sign Route 1 has been developed as an expressway to 19th Avenue in San Francisco. This portion has been in service since 1956.

North of San Francisco, planning studies for relocation of Sign Route 1 between one mile north of Golden Gate Bridge and Point Reyes Station are almost completed. Public meetings will be held soon on the route determination. Funds in the amount of $120,000 have been provided in the 1960-61 budget for drainage and paving projects at various locations on the Marin coast. $230,000 has been provided for work on portions between 0.4 mile south of the Marin county line and Bodega Bay.

Route 105—San Mateo and Alameda Counties

Design is under way and rights-of-way are being acquired for a freeway between El Camino Real and the Hayward-San Mateo Bridge and westerly to Junipero Serra Freeway.

The freeway route for the portion in San Mateo County (19th Avenue Freeway) from Sign Route 5 (Skyline Boulevard) to the Alameda county line, a distance of 7.2 miles, was adopted in 1957 by the State Highway Commission. That portion of the route in Alameda County between the county line and Nimitz Freeway was adopted in 1952, and preliminary design has been started.

Preliminary studies have been completed for the widening of the San Mateo Bridge to four lanes and for converting its approaches to freeway standards. These were made by the Division of San Francisco Bay Toll Crossings.

East of the Nimitz Freeway, design studies are well advanced for the interim improvement of this route as a four-lane divided conventional highway along Jackson Street in the City of Hayward.

Stevens Creek Freeway

Design studies are underway and rights-of-way are being acquired for an eight-mile section of this important cross-country facility from Sign Route 17 in Los Gatos to the Bayshore Freeway near Mountain View. From Azule south of Junipero Serra Freeway, the route will be developed as an initial six-lane freeway. The portion from Junipero Serra Freeway to Bayshore Freeway (US 101 Bypass) will be developed as an initial four-lane freeway. Design studies have also been started on the portion of this route between Sign Route 17 and Azule.

Funds have also been provided in the 1960-61 budget for an interim improvement within Sunnyvale pending completion of the future freeway. This project, estimated to cost approximately $220,000, will provide a four-lane divided arterial along Mathilda Avenue between the Southern Pacific Railroad east of El Camino Real in Sunnyvale to Bayshore Freeway. Rights-of-way are being acquired by the City of Sunnyvale.

Mountain View-Milpitas Area

Approximately one mile of initial four-lane development on Sign Route 9 between Bayshore and 0.2 mile east of Borregas Avenue is included in the $4,760,000 contract which will be advertised shortly for completion of US 101 Bypass (Bayshore Freeway) in Mountain View.

Major construction in this area during the past year was the completion of the interchange at the intersection of Bayshore Freeway and Mountain View-Alviso Road. This $1,257,000 contract completed in July is covered previously in this article in connection with the discussion of US 101 Bypass.

Design studies are in progress for the portion of this route between US 101 and Nimitz Freeway. Development is planned as an initial four-lane freeway with provisions for a future six lanes. This route was adopted in 1954. Since 1957 two lanes of the future Alviso Bypass Freeway have been in operation between Lawrence Station Road and the San Jose-Alviso Road.

Between El Camino Real and Bayshore Boulevard the route was adopted in September of 1958. An initial four-lane freeway is planned for this 2.5-mile section.

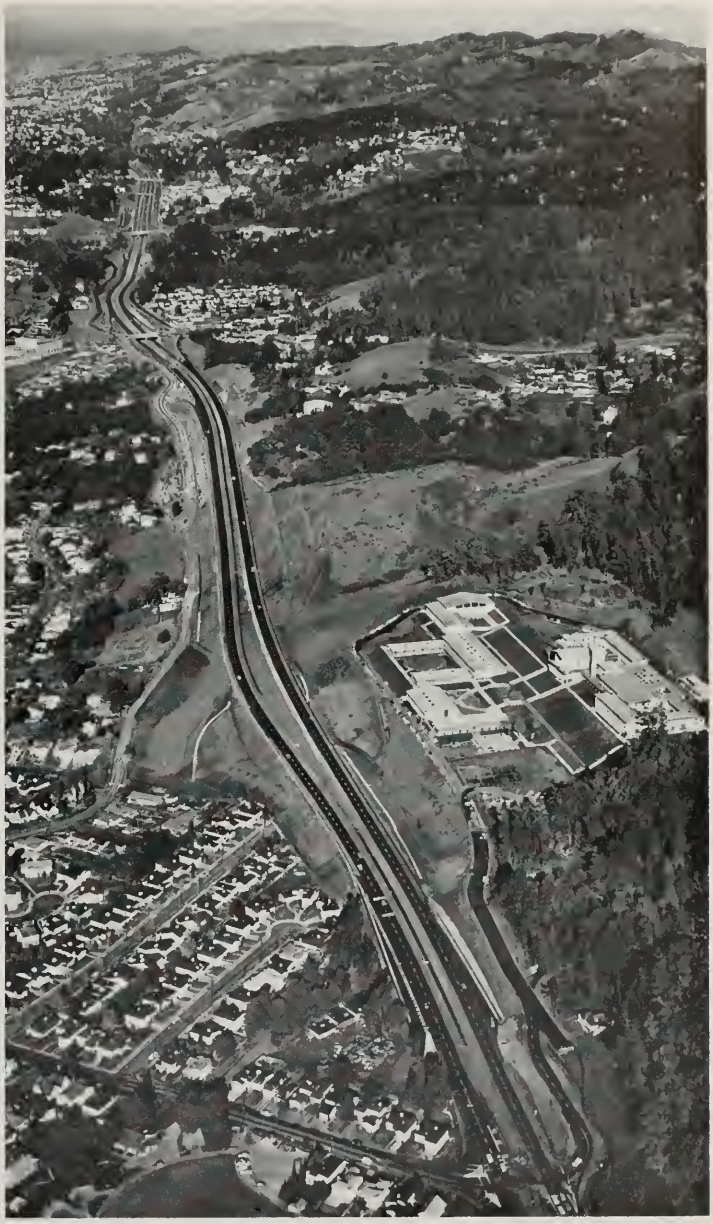
Route 228—Nimitz Freeway to US 50

Additional landscaping has just been planted in a $90,500 contract between Center Street in Castro Valley on US 50 and the Nimitz Freeway. This work supplements planting placed under a previous contract.

This important freeway connection between Sign Route 17 and US 50 was completed in September of 1956, providing continuous freeway and expressway between the Bay Bridge and Tracy in San Joaquin County.

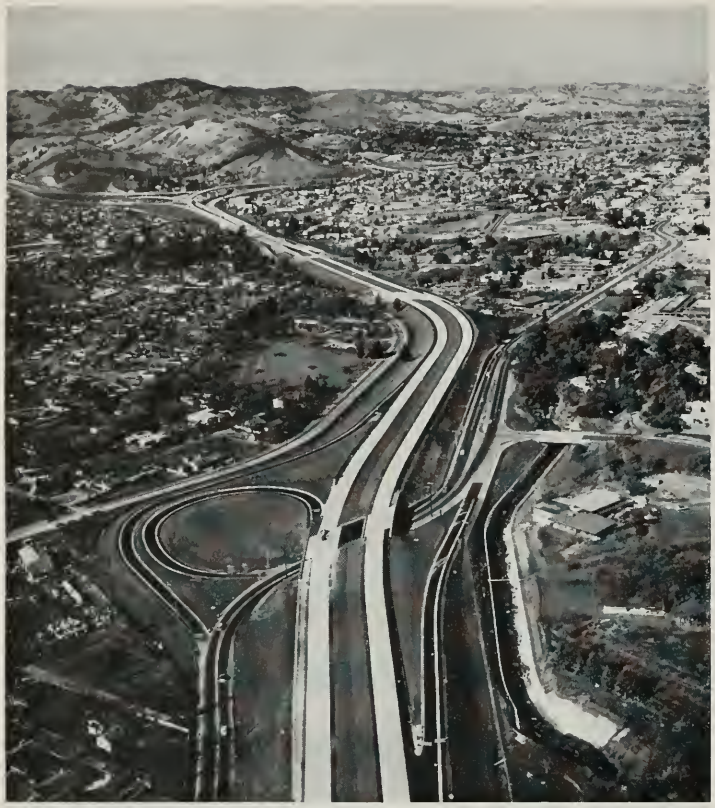
Webster Street Tube

A $20,000,000 contract is presently under way for the construction of a parallel two-lane tube and approaches between Oakland and Alameda. The new underwater tube will be 3,350 feet long from portal to portal and the all-tiled interior of the tube will be illuminated by continuous fluorescent lighting. An extensive ventilation system to supply nearly a million cubic feet of fresh air per minute inside the tube will be installed.



New section of Warren Boulevard in Oakland looking north from Redwood Road to Lincoln Avenue.

The portion of the tube between First and Fourth Streets in Oakland will be built in place in a trench and then backfilled. The remainder of the tube will be constructed by sinking precast sections in a dredged trench



South Main Street Interchange on SSR 24 in Walnut Creek, with new Walnut Creek "Y" Interchange in upper left.

and backfilling with a sand blanket in the underwater area. Twelve tube sections, each 200 feet long and 37 feet in diameter will be built in dry dock, floated to the proper location, sunk and connected in final location at depths up to 90 feet. This is the 12th underwater vehicular tube to be constructed by this method throughout the world. The adjacent Posey Tube, which was completed in 1928, was the first.

Included in the work is the proposed Fourth Street Overcrossing adjacent to the Eastern Portal building and temporary structure for the support of the main line Western and Southern Pacific Railroads. Temporary structures are also required for support of major utilities, including sewers, during construction. This work is being performed as a joint venture by Pomeroy-Bates and Roger T. Gerwick and is expected to be completed late in 1962.

Upon completion of the new tube, the existing Posey Tube will be closed for rehabilitation and inter-connecting work under another project. At the completion of this work, the two tubes will be operated as one-way facilities.

Several other contracts were required to relocate U.S. Government facilities and replace in kind, storage areas purchased from the Departments of Army and Navy for tube construction. The first of such contracts was completed in 1958 providing a paved storage area for the Naval Air Station in Alameda. A major relocation contract was completed in 1959 by Arntz Brothers at a cost of $287,000. This work consisted of partly dismantling and relocating a 600-foot by 150-foot metal hangar from within the required right-of-way to a new location within the Naval Air Station. The hangar was reconstructed as a 300-foot by 300-foot building. Additional contracts will be required to relocate the railroad marshaling yards adjacent to the U.S. Army depot; reconstructing the existing sewer outfall from the service installations and providing additional paved storage areas.

Warren Boulevard (Mountain Boulevard)

Another unit of this route, being developed jointly by the State, County of Alameda, and the City of Oakland, was recently completed providing a continuous freeway between Broadway Terrace and Redwood Road in Oakland. This route from State Sign Route 24 near Lake Temescal to a connection with the future MacArthur Freeway (US 50) at Calaveras Street near Mills College was originally established by Joint Highway District No. 26. Although this district was dissolved by the Legislature in July of 1954, the City of Oakland and Alameda County have agreed to continue to provide a total of $300,000 per year until 1961 for completion of this initial four-lane, future six-lane freeway.

Between Broadway Terrace and Lincoln Avenue, the freeway has been in operation since August of 1958. The 1.6-mile portion recently completed from Lincoln Avenue to Redwood Road was constructed as a joint venture by Frederickson and Watson and Ransome Company and cost an estimated $1,088,500. Also completed during the past year was a landscaping contract between Park Boulevard and Lincoln Avenue at a cost of $19,000.

Design studies are well advanced for the remaining portions of this freeway between the end of the completed project and MacArthur Freeway.

Shepherd Canyon Freeway

Freeway agreements have been executed and design studies are proceeding for the development of this 10.3-mile route as an initial four-lane, ulti-

mate six-lane freeway. Beginning at Warren Boulevard at the Park Boulevard Interchange, the route adopted in December 1956 follows Shepherd Canyon adjacent to the abandoned Sacramento Northern Railroad. A tunnel, approximately 1,400 feet long, will be required through the Oakland Hills. Crossing Moraga Valley just north of the present townsite, the freeway will terminate at Sign Route 24 at Pleasant Hill Interchange.

Route 107—Dumbarton Bridge to Niles

The route for this 5.7-mile section between Dumbarton Road and Sign Route 9 at Niles has been adopted and surveys are under way. An initial four-lane, future six-lane facility is to be developed on new alignment north of the existing highway. Some rights-of-way are being acquired.

Route 108—Sunol to Livermore

A public hearing was held by the Highway Commission on September 25, 1959, concerning a freeway routing for a 10-mile section of Highway Route 108 between Sunol and US 50 near Livermore, but further action toward adoption of a route is being deferred pending studies of an extension of Route 108 to the north of US 50. This extension was added to the state highway system by the Legislature in 1959.

Arnold Industrial Freeway (Sign Route 4)

Design studies are well advanced for portions of this route from US 40 near Hercules to Willow Pass Road northeast of Concord. The freeway route for this section was adopted in October, 1958. A short relocation and the interchange with US 40 was constructed in conjunction with the construction of US 40.

From Willow Pass Road to Neroly Road east of Antioch, the route is covered in this article under Sign Route 24 since within these limits



Healdsburg Bypass, looking east from intersection of new construction with existing highway at Grant. City of Healdsburg in background. Russian River in center with bridge crossings (left to right) at freeway, old highway and NWP Railroad.

both routes are identical. Presently under way within these limits is a $33,250 landscaping project at Railroad Avenue Interchange in Pittsburg.

Grove Shafter Freeway

Rights-of-way are being acquired and design studies are well advanced on this important link between the Nimitz Freeway and the Broadway Tunnel. An eight-lane freeway is planned. Footings for the future interchange connections with MacArthur Freeway will be placed as a part of a 1960-61 budget contract on MacArthur Freeway. Detailed plans for this important interchange are pending as a result of the rapid transit studies in this area.

Sign Route 12

A freeway route 17 miles long was adopted in January 1957 between Sebastopol and Kenwood. Design studies are under way and some rights-of-way are being acquired. On the 13.8-mile section of Sign Route 12 between Kenwood and Schellville, preliminary planning studies are in progress.

Sign Route 37 (Black Point Cutoff)

In June of 1959, 6.7 miles of initial four-lane expressway were completed between US 101 at Ignacio Wye and Sears Point. One million eight hundred sixty thousand dollars was spent in constructing two additional lanes, the Atherton Avenue Interchange, and approaches to the new Petaluma Creek high level structure completed in 1958. This was the second stage construction within these limits.

From Sears Point to the Napa county line, planning studies are under way for a future six-lane freeway.

In 1955, the initial two lanes of a future four-lane freeway were constructed from a point two miles east of the Napa county line to 2.2 miles east of Carneros School. Design studies are under way for portions of an initial two-lane expressway, which will ultimately be developed to a six-lane freeway between the Sonoma county line and Imola Avenue in Napa. East of Napa, planning studies are being made for possible relocation and future improvement.

Sign Route 29

Funds have been provided in the 1960-61 budget for the first unit of a 3.25-mile initial four-lane freeway between Imola Avenue and Union Station in Napa County. Included in the first contract will be construction of the Old Sonoma Road Overcrossing and frontage roads between Imola Avenue and Sonoma Road. North of Napa, 2.3 miles of four-lane expressway between Union Station and Orchard Avenue were completed in 1957. From Orchard Avenue to the newly completed Yountville Bypass, rights-of-way are being acquired and design studies are in progress for a four-lane expressway.

Two lanes of the future four-lane expressway bypassing Yountville were completed in July of last year. Work on this 2.9-mile section included construction of the California Drive Undercrossing. The route has been adopted in its entirety between Napa and Rutherford and design studies are proceeding on the remaining portion. Public meetings have been held on the portion of the future four-lane freeway between Rutherford and St. Helena. North of St. Helena, 3.8 miles of two-lane, future four-lane expressway between St. Helena and Calistoga have been in service since 1956.

South of Napa, studies are being made for right-of-way acquisition for a future six-lane freeway between Imola Avenue and the Solano county line. These sections of Sign Route 12 and 29 have been operating for many years as a four-lane expressway.



Posotiempo Interchange, looking south towards Santa Cruz on Sign Route 17.

Summation

Signs of prodigious postwar growth in the Bay area may be seen on every hand superimposed upon the unique but unchanging face of the bay and its surrounding hills and valleys. Not the least of these changes is evident in the hundreds of miles of freeways constructed since 1947.

The freeways, because of their inherent long-range planning based on

STATUS OF DISTRICT IV FREEWAY AND EXPRESSWAY PROJECTS

March 1960

Description	Total miles	Completed projects		Under contract		Budgeted		Right of Way expended and budgeted
		Miles	Construction cost	Miles	Construction cost	Miles	Construction cost	
US 101 AND 101 BYPASS								
Bayshore and James Lick Memorial Freeway US 101 Bypass, Southern Freeway in San Francisco to Ford Road South of San Jose	52.9	38.7	$39,716,000	5.6	$6,609,000	8.6	¶$12,323,000	$23,389,000
Southern Freeway	4.7				**8,930,000	2.3	11,025,000	18,109,000
James Lick Memorial Freeway	3.0	3.0	11,427,000				10,000	12,870,000
Central Freeway	1.8	1.8	11,862,000		66,000		100,000	8,552,000
Golden Gate Freeway	1.1					1.1	5,100,000	889,000
Ford Road South of San Jose to San Benito County Line (portions)	5.8	5.8	1,093,000					546,000
Redwood Freeway; Golden Gate Bridge to Mendocino County Line	84.3	51.9	*37,226,000	3.7	3,641,000	9.2	6,630,000	13,736,000
US40; SAN FRANCISCO TO CARQUINEZ BRIDGE (portions)	18.2	15.9	§56,517,000	2.3	5,583,000		435,000	13,292,000
US 50								
MacArthur Freeway; distribution structure to Castro Valley	15.3			1.5	10,000,000	2.7	13,000,000	43,470,000
Castro Valley to San Joaquin County Line	31.4	31.4	11,662,000					6,370,000
SIGN ROUTE 17								
Nimitz Freeway, distribution structure to Bayshore Freeway at San Jose	41.3	41.3	55,123,000		215,000		4,995,000	21,681,000
Santa Cruz to San Jose (portions)	19.9	10.6	9,288,000	7.1	6,266,000	2.2	1,775,000	9,849,000
US 40 near Albany to US 101 near San Rafael (portions)	9.9	2.4	1,973,000					1,805,000
SIGN ROUTE 9 AND 21								
Warm Springs to US 50 (portions)	9.7							578,000
US 50 to Walnut Creek	16.0	2.1	550,000	1.4	2,360,000		150,000	7,320,000
Walnut Creek to Monument	3.4	2.0	2,868,000	1.4	6,236,000		200,000	6,801,000
Monument to Solano County Line	7.4					3.2	†6,833,000	3,022,000
Sign Route 9 North of Route 21 in Fremont	2.2							
GROVE-SHAFTER FREEWAY AND SIGN ROUTE 24								
Sign Route 17 in Oakland to Warren Boulevard	4.8							2,988,000
Warren Boulevard to Walnut Creek	11.0	6.8	9,561,000		39,000	0.8	10,125,000	5,584,000
North of Monument to Sign Route 4, Concord	3.4		226,000					867,000
EMBARCADERO FREEWAY	1.5	1.5	14,764,000					12,285,000
PARK—PRESIDIO FREEWAY, GOLDEN GATE BRIDGE TO FULTON STREET	2.1	1.2	1,448,000					3,000
JUNIPERO SERRA FREEWAY								
US 101 South of San Jose to Sign Route 17	10.0							335,000
Sign Route 17 to San Francisco County Line	43.9							6,448,000
CABRILLO HIGHWAY								
San Pedro Creek to Lake Merced Boulevard in San Francisco	10.0	5.4	2,766,000					2,012,000
Watsonville to 4 miles South of Davenport (portions)	22.8	12.4	6,299,000	3.1	631,000			2,879,000
JUNIPERO SERRA FREEWAY TO NIMITZ FREEWAY								
19th Avenue Freeway, Junipero Serra Freeway to Alameda County Line at San Mateo Bridge (portions)	8.0							3,301,000
San Mateo County Line to Nimitz Freeway	6.8							25,000
PACHECO PASS: 1 MILE EAST OF BELL'S STATION TO MERCED COUNTY LINE	5.3	5.3	1,285,000					12,000
WEST OF US 101 TO BYPASS US 101 IN REDWOOD CITY (ROUTE 214)	1.1							500,000
STEVENS CREEK FREEWAY, SIGN ROUTE 17 TO BAYSHORE FREEWAY AT MOUNTAIN VIEW	13.6							2,989,000
MOUNTAIN VIEW—ALVISO FREEWAY—EL CAMINO REAL TO EASTSHORE FREEWAY	10.5	2.1	1,006,000			1.1	850,000	699,000
FREEWAY CONNECTION FROM NIMITZ FREEWAY TO US 50 (ROUTE 228)	2.2	2.2	2,803,000					2,467,000
BAY FARM ISLAND BRIDGE AND APPROACHES	0.6	0.6	2,062,000					165,000
WEBSTER STREET TUBE	1.1		203,000	1.1	17,363,000			3,073,000

STATUS OF DISTRICT IV FREEWAY AND EXPRESSWAY PROJECTS—Continued

March 1960

Description	Total miles	Completed projects		Under contract		Budgeted		Right of Way expended and budgeted
		Miles	Construction cost	Miles	Construction cost	Miles	Construction cost	
Warren Boulevard Freeway: Sign Route 24 near Lake Temescal to MacArthur Freeway	5.6	4.1	‡5,612,000					1,735,000
Tracy Triangle: (Route 110) US 50 to San Joaquin County Line	0.4							
Shepherd Canyon Freeway; Warren Boulevard Freeway to Sign Route 24	10.3							450,000
2.6 Miles East of Dumbarton Bridge to Sign Route 9 at Niles	5.7							50,000
Arnold Industrial Freeway; (Sign Routes 4 and 24) Hercules to Antioch Bridge	34.1	14.7	4,694,000					1,610,000
Sign Route 12; Sebastopol to Kenwood	17.7							2,672,000
Sign Route 29; Solano County Line to Calistoga (portions)	35.7	22.2	3,472,000			0.5	400,000	3,664,000
Sign Route 48; Sign Route 37 to Solano County Line	2.3							
Sign Route 37; from Redwood Freeway at Ignacio to Napa	13.4	7.2	5,900,000					832,000
Totals	612.2	292.6	$301,406,000	27.2	$67,939,000	31.7	$73,951,000	$249,924,000

* Includes total of $5,000,000 by Golden Gate Bridge and Highway District.
** Includes total of $1,600,000 by City of San Francisco.
† $6,833,000 from Toll Bridge Funds.
‡ City of Oakland and Alameda County contributions included in this figure.
§ $29,117,000 Toll Bridge Funds in this amount.
¶ Includes $300,000 contributed by co-operating agencies.

comprehensive traffic, population and economic projections, have been in the forefront of regional development during the past 10 years.

Symptomatic of mounting awareness of transportation's role on the national, state and local scenes are the Federal Highway Act; the Highway Commission's policy placing more emphasis on local participation in highway matters; Senate Concurrent Resolution No. 26 and its resultant freeway and expressway legislation (which added 266 miles of state highways in District IV); the current Senate Concurrent Resolution No. 62 deficiency studies on city streets and county roads; the resurgence of Bay area rapid transit studies; the formation of the Golden Gate Authority Commission; and studies by local associations to arrive at staggered working hours in an effort to spread peak-hour congestion.

A part of the kaleidoscopic scene stems from efforts to reduce pressures built up by geographical limitations; the new Richmond-San Rafael Bridge; a parallel Carquinez Bridge; present construction of the Martinez-Benicia Bridge and the Webster Street Tube; proposed parallel construction of the San Mateo Bridge and further modifications to the Golden Gate Bridge; contemplated construction of a Southern Crossing and rapid transit tube; current revamping of the San Francisco-Oakland Bay Bridge; and a soon-to-be-constructed parallel tunnel through the Oakland hills.

Over and above the immediate problem of providing for commuter and other traffic is increased emphasis on landscaping and aesthetic blending of transport facilities, and the contemplation of a leisurely, scenic Skyline National Parkway from the Golden Gate to Monterey Bay.

The tempo of change, past and present, indicates portentous years ahead. Governor Edmund G. Brown recently expressed the shape of things to come thusly: "Freeways should be more than a way of moving motor traffic rapidly. They can and must be related to other aspects of a community's life: its historic landmarks, its parks and residences, its plans for urban renewal, its natural beauty."

Commission Allocates Contingency Funds

At its March meeting the California Highway Commission allocated $12,590,000 for major highway projects in 11 counties. The projects were added to the 1960-61 State Highway Budget.

State Director of Public Works Robert B. Bradford, commission chairman, said the allocations were from contingency reserves and from savings accumulated from favorable bids on construction projects.

Hatchet Mountain

Modern Highway Replaces Tortuous Mountain Road

By ROBERT J. FELTON, District Construction Engineer and
WESLEY W. JONES, Resident Engineer

On December 10, 1959, construction was completed on the final unit of U.S. Highway 299E between Montgomery Creek and Burney Valley in Shasta County. The section now consists of 15 miles of modern two-lane highway traversing rugged mountainous terrain constructed at a cost of $3,181,488, partly financed by federal aid funds administered by the Bureau of Public Roads.

In 1950 the route consisted of 16 miles of tortuous mountain road. There were 159 curves for an average of one curve for every 533 feet of road. Minimum radius of curvature was 50 feet.

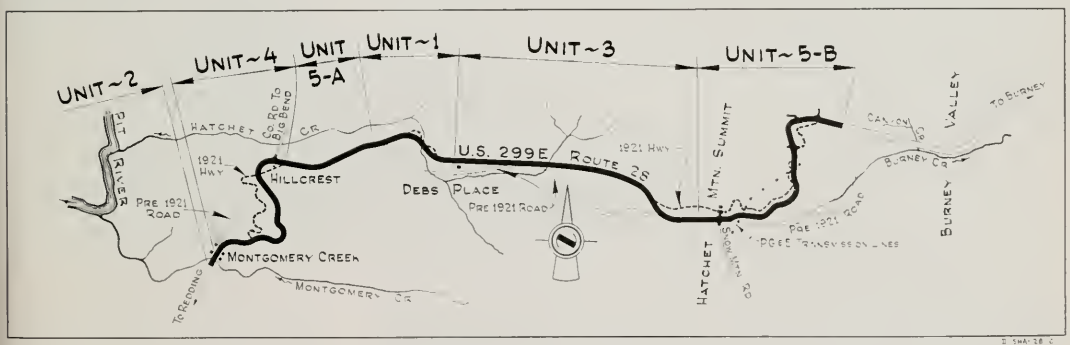
U.S. Highway 299E is the connecting line between U.S. Highway 99 at Redding, and U.S. Highway 395 at Alturas approximately 140 miles to the east. The section rises from elevation 2,136 feet at Montgomery Creek to elevation 4,366 feet at Hatchet Mountain Summit and descends to elevation 3,279 feet at Burney Valley. Snow packs of four feet are common at the summit with a maximum pack of 12 feet. The use of chains is frequently mandatory on the entire section during the winter storms.



East from Hatchet Mountain Summit showing completed road (Burney Valley in background).

Curves Reduced

Reconstruction of the section has reduced the number of curves to 35 and increased the minimum radius to 600 feet. Maximum gradient is now 7 percent as compared to a maximum



Relocation of U.S. Highway 299E over Hatchet Mountain Summit was started in 1950 and completed in 1959. The new highway has eliminated 124 curves and shortened the distance by one mile over the original route.

of 6.5 percent on the former alignment. The increase in maximum gradient on the new alignment was necessary due to the reduction in length of the section.

Improvement of the section was accomplished in five construction units as indicated on the vicinity sketch.

Unit No. 1 consisted of replacing Hatchet Creek Bridge with a 16-foot concrete arch culvert and constructing 1.61 miles of roadway. The work was done by Eaton and Smith Construction Company between October 1950 and November 1951, at a cost of $355,776.

Unit No. 2 consisted of constructing a new bridge across Montgomery Creek and constructing 0.35 mile of roadway approaches. The work was done during 1952-53 by B. S. McElderry Company at a cost of $98,324.

Unit No. 3 consisted of constructing 4.93 miles of roadway terminating at Hatchet Mountain Summit. The work was done by Fredrickson and Watson Construction Company between May 1955 and July 1956 at a cost of $646,097.

Unit No. 4 consisted of constructing 3.56 miles of roadway at the Montgomery Creek end of the section. The work was done by Eaton and Smith Construction Company between May 1955 and December 1956 at a cost of $659,604.

Metal Underdrains Used

A considerable amount of work was done on subsurface drainage in excavation areas on this unit. Perforated metal pipe underdrains were placed beneath the roadbed and two-inch steel pipe horizontal drains were drilled into cut faces to dewater unstable slide areas.

In December 1957 a crack appeared along the centerline of the pavement in the center of a 70-foot embankment 1.2 miles east of Montgomery Creek. The slide continued until the southerly half of the roadbed was 15 feet lower than the northerly half. At this point, the entire roadbed began to settle resulting in complete failure.

Investigation revealed that unstable material located a minimum of 15 feet below original ground had become saturated and lost its ability to support the embankment. As the embankment settled, the original ground rose over a comparable area approximately 100 feet from the toe of the embankment.

... Continued on page 69



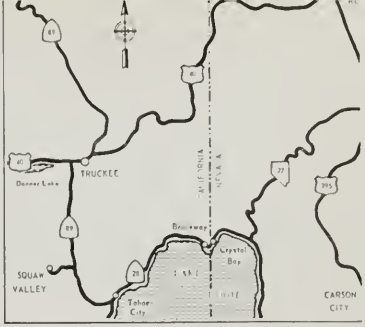
Snow removal operations at the summit.



Normal winter snow conditions between Montgomery Creek and Burney Valley. Auto is ascending east slope of Hatchet Mountain near summit on recently completed alignment.

OLYMPICS TRAFFIC

By ALAN S. HART, District Engineer, District III



SERIOUS planning for handling the traffic during the Winter Olympics at Squaw Valley in 1960 started four years before with the official announcement of the Squaw Valley choice at the games in Italy. A transportation committee to study the problem was formed of representatives of the Olympic Commission, the California Division of Highways, the Highway Patrol, and other concerned activities, and it immediately went to work. The Division of Highways representative was State Highway Engineer J. C. Womack, then Assistant State Highway Engineer (Planning).

The Squaw Valley site is a beautiful one, but the absence of a closeby city was a subject of concern for the planners. With Reno, 44 miles away, the nearest sizable city, and virtually no facilities for food and lodging within the valley itself, considerable work had to be done to make it feasible for the public to visit the games.

There was no way to provide any appreciable amount of additional lodging for such a short period, so obviously visitors must be transported in on a day-by-day basis. For the majority of the visitors, this meant in typical American fashion—behind the wheels of their own cars. Traffic would be a problem, requiring adequate roads and tremendous parking areas.

The biggest worry was the weather. Donner Pass and Donner Lake, only a dozen miles from Squaw Valley, are named for the ill-fated Donner Party of pioneer days. Caught just east of the pass in a severe snowstorm, they were trapped and completely immobilized by succeeding storms. Many of the party starved to death.

Storms can come up rapidly in this part of the Sierra Nevada, and snowfalls of six to eight inches an hour are not uncommon. What would happen if such a storm came up while the games were in progress?

The highway maintenance men knew that keeping a lightly traveled highway open in a snowstorm is not difficult except under the worst blizzard conditions, but that the trouble almost invariably starts when a truck jackknifes, or a pair of cars lock bumpers, or several are involved in a skidding accident. Then the plows are stymied, the snow starts piling up, and "the road is lost."

If the worst happened, and such a sudden storm struck, a mass evacuation of the valley might result in a disaster which would make headlines in every newspaper in the world. Nervous, worried motorists were virtually certain to get into accidents, the plows would be immobilized, and literally thousands of people would be trapped.

This was the biggest worry. Another was if "chaining up" should become necessary. Virtually all the traffic would originate in the snow-free lowlands, and none of the cars would start for the mountains with skid chains on their wheels. This is a routine problem to the Division of Highways maintenance superintendent in a mountain area—he sets up and removes chain control points many times each winter month.

Olympic visitors might be required to put on chains at some point on the way up, or a snowfall during the day might make chains necessary to get back down to the valley that evening. If on the way up, there was the prospect of thousands of cars stopped on US 40 in the dim light of dawn, their drivers cold, irritated, and many of them inexperienced at putting on chains. If chaining should be required before departure from the valley there was the worse prospect of complete chaos as 10,000 motorists, jammed together on the big parking apron, tried to maneuver on to their chains. If this occurred coincident with a storm, no doubt thousands would have to be evacuated in buses.

The third worry was parking. In a city parking lot, 225 square feet per car is considered adequate. In the mountains it was felt twice that would

Navy roller towed by small tractor continues work on compacted snow entrance road while traffic enters parking lot.





Parking lot at Squaw Valley on a weekend with attendance about 25,000 (7,000 cars in lot). Composite photo

be needed, which would dictate a main parking lot of at least 100 acres. This would allow heavy equipment to operate in and through the lot, provide overflow space for buses, and give the motorists room to maneuver under difficult conditions.

There was not nearly this much parking space in the valley. The cost of buying, grading and paving such a space would be enormous, with no hope of getting it back in one short, 10-day season. It also would be an eyesore in the valley which was to be a state park, and it would ruin some excellent summer pasture land.

The Navy suggested it might be able to provide parking space by the snow compaction method it had been experimenting with for Arctic air fields, if Congress would appropriate the money. The money was appropriated, and the Navy's plan was accepted—not without misgivings in some quarters. The idea was revolutionary and untried, but the Navy insisted it was practicable. Navy Sea Bees did some experimental work in Squaw Valley in 1958, and then compacted a large parking area in 1959.

The major route to Squaw Valley, both from the east and the west, is US 40, which connects San Francisco to Reno, and continues east to the Atlantic seaboard. This route has been designated part of the US Interstate System, so it ultimately must be improved and realigned over almost every one of its 3,000 miles.

Whenever possible, the Highway Commission authorized expenditures on the modernization of US 40, with the result that all but 36 of its miles between San Francisco and the Nevada state line was four-laned by the time the 1960 Olympics opened. Much of it was full freeway to interstate standards. Between June 1958 and January 1960, 48.7 full-freeway miles of this route between Sacramento and Nevada state line were completed at a cost of $42,685,000.

State Sign Route 89, connecting US 40 with Lake Tahoe and the final access highway from both directions to Squaw Valley, was widened and resurfaced. There was some concern because a narrow, two-lane underpass beneath the Southern Pacific Railroad on State Sign Route 89 was not improved, but this was deemed too expensive and difficult an undertaking at the time. As an alternate plan, a county road, River Street extension, which leads into Truckee and US 40 by a slightly roundabout route, was improved at nominal cost as an overflow road, and as an emergency route in case of evacuation.

In February 1959 the North American Ski Championship competition was held in Squaw Valley, giving everyone a chance for a dress rehearsal—Navy, Highway Patrol, and Division of Highways.

The competition was held on the three-day Washington's Birthday weekend—Saturday the 21st through Monday the 23d—and on the following weekend. On the 18th torrential rains softened the Navy's parking pad so it was unusable, and the cars of 10,000 visitors had to be parked wherever possible in the valley, on the access roads, and along State Sign Route 89 outside the valley entrance. However, the temperature dropped on Sunday, and by Monday the parking pad could be used. Although about a foot of snow fell each day between Tuesday and Friday, the following Saturday dawned clear and cold. The weekend's crowds were handled without difficulty.

Applying the lessons learned from the North American Championships, all the agencies modified and refined their planning as the time for the Olympic Games approached. A new system of drainage was installed in the parking area. The Highway Patrol arranged to take over Truckee High School as headquarters and barracks. On February 1, 1960, they moved in bunks, cooks, a large force of patrolmen, and patrol cars. Cooks were instructed to feed a minimum 3,600 calories a day cold weather diet.

Special destination signs were installed by the Division of Highways.



three photographs by William Chaney, Division of Highwoys photographer. View is generally south ocross valley.

Some new rotary plows and other equipment had already been purchased for the higher altitude maintenance stations, and additional equipment was moved in from other districts on a short term loan basis. Maintenance Superintendent Frank B. Fox of the Truckee territory assumed responsibility for maintaining the access road into Squaw Valley to the Administration Building, under financial agreement with Placer County and the Olympics Commission. Headquarters Maintenance Communications Section included the Squaw Valley weather forecast in its daily road condition report.

Convertible overhead signs were placed at several points on State Sign Route 89, so that the route could readily be converted to three lanes in one direction and one in the other, at any time. A special communications network, both teletype and radio, connected the various highway and Highway Patrol units with each other and with their respective Sacramento headquarters. A number of trailers were brought in, and permanent liaison groups from several agencies were assigned in Squaw Valley itself for the duration of the games.

In January and February 1960, just prior to the opening of the games, a series of storms swept across California. The first storms were cold, and several feet of snow fell in the mountains. Then tropical air masses moved in from the Pacific, and rain fell at high altitudes.

On February 6 a slide closed US 40 east of Monte Vista, so that the previously constructed Alta detour had to be used, but this slide was cleared in two days. A more serious slide started at the new Whitmore Maintenance Station above Baxter. Beginning near the old highway, it gradually broke back across the wide slope area between the two roadways, until it undermined the fill of the recently completed section. Before it stopped moving, about 200 feet of paving was lost, and traffic was diverted to the old route for several days until a temporary "shoofly" detour could be built.

On the eighth of February more than five inches of rain fell in a few hours in Squaw Valley, flooding the entire valley floor, and nearly washing out the entrance road bridge over Squaw Creek. Sign Route 89 was closed three times on this one day by fallen trees. The compacted snow parking pad in the valley seemed hopelessly ruined. With the Olympics just 10 days away, it was necessary to make emergency plans.

On the 9th and 10th there was heavy snow and wind. All except official vehicles and those of residents were barred from the valley so that the maintenance crews could clear the roads.

The parking pad was still usable by the 11th, and traffic from sightseers and skiers was increasing. But cars were allowed to enter the valley again on the 11th, and 625 were parked along the wide section of the entrance road that day, 650 the next.

The dedicated Navy crews were working hard all this time, and the new snow helped. They hoped to have part of the lot back in shape by Saturday, the 13th, to handle a part of the weekend sightseer and skier traffic.

The Division of Highways crews in the meantime worked most of the night getting signs ready to direct traffic to parking on an old section of US 40 near Truckee. The Greyhound Bus Company got some of the large resorts in the State Line area at Lake Tahoe to clear their parking lots for car storage so Squaw Valley travelers could take the shuttle buses from there. Officers from both Nevada and California Highway Patrols visited every motel and lodge at the north end of the lake, telling people to leave their cars at the motel and take the shuttle buses.

At this time the situation seemed to be that the shaky parking lot would be continued in use until about 11 or 12 o'clock, and if the influx of cars continued heavy, then parking would be shifted to the already designated

areas near Truckee. Crews were at work placing signs that morning with bolts so they could be reversed when desired, when the word came at 9.30—"The pad just went." Highway patrolmen immediately began diverting traffic, and the crews finished the signing virtually on the run, not bolting, but nailing the signs in place.

There were just two lanes available in the old section of US 40, with high snow banks on either side. Cars entered at one end of the six-mile loop, and parked in progression one behind the other, filling one lane. The shuttle buses entered at the other end of the loop, using the remaining lane to move forward and load. This system worked admirably, except that there was a delay in getting enough drivers immediately for the shuttle buses, both at Truckee and at Lake Tahoe.

The emergency parking area at Truckee proved unusable, however, in the afternoon, when passengers returned on the buses to their cars. Whereas parking in the morning had been progressive along the area as it filled, the buses naturally were loaded at random in the evening. Cars continuously pulled out from the parking lane at many points and blocked the buses. This problem had been anticipated to some extent, so that the buses in the afternoon reversed their morning direction and moved with the traffic, but they still were immobilized.

At an emergency meeting between Division of Highways and Highway Patrolmen that afternoon, it was decided to use the outside shoulders of the new freeway sections of US 40 for emergency parking—both east and west of Truckee. To facilitate the movement of the shuttle buses on their return from the valley that next afternoon (Sunday), the Division of Highways crews worked all night making zone signs for the parking areas. They also posted 13 miles of highway with burlap-covered 25 miles per hour signs, which could be uncovered when parking, loading and unloading was in progress. The Highway Patrol administrative section was meanwhile working on instruction leaflets for parkers, explaining how the zone system worked. Maintenance crews worked all night clearing the snow from the shoulders in the designated parking area.

Essentially, the plan was to have each driver keep his leaflet, and to write his zone code on it. When he was ready to return from the valley on the shuttle bus that afternoon, he and his car group would board the bus marked for his zone.

The plan was never needed. That night the temperature dropped almost to zero. The hard working Navy crews had continued to work on the parking pad, and the cold solidified it.

At 0730 hours on the 14th the Navy reported, "Compacted area officially open," and at 0742 hours "Pad looks good." At 1046 hours, the Patrol reported "Pad is holding up good. Temperature favorable—will probably hold 1000 or 2000 vehicles if nothing happens. Six hundred to 700 parked at this time."

Nothing did happen, and at 1326 hours the patrol reported the peak seemed to have been reached. The parking lot had handled between 1200 and 1300 cars at the peak without incident. During the games it handled many thousands more than this on several days.

Handling the traffic for the Olympic games themselves was almost an anticlimax. Minor problems arose, of course, but in general, things went very smoothly. There was no rain and only two light snowstorms during the days the games were on. Nights continued cool—close to and sometimes below zero and the pad functioned perfectly.

On the 21st, which was Sunday and the middle day of a three-day weekend, the weather in the valley was

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Main Olympic Games area on the biggest attendance day, showing mast of the 310 special buses in central parking area. Compacted snow parking area at top. At lower right, crowds watching ski races.



Data Processing

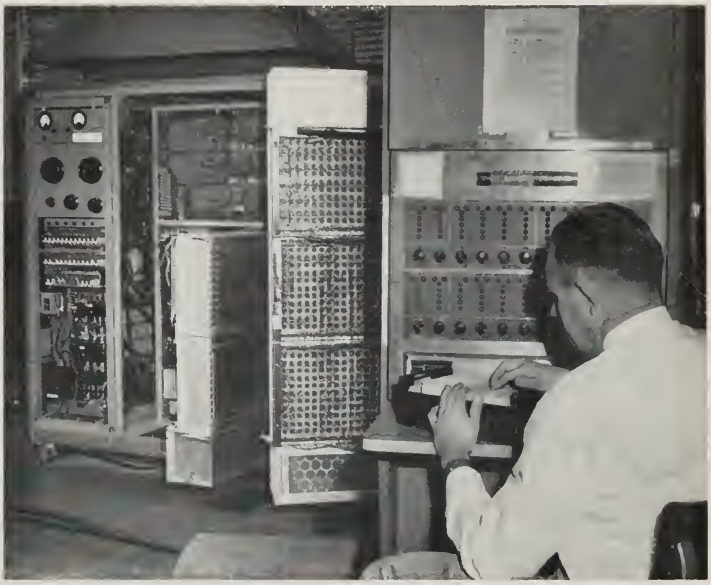
New Tabulating Methods Speed Design Calculations

By F. M. REYNOLDS, Highway Planning Survey Engineer

DATA FOR administrative decision and for the location and detailed design of modern highways are being processed at an ever-increasing rate in the tabulating and data processing section of the Headquarters Highway Planning Survey.

The division's present activity and capacity in the field of data processing is the modern result of early beginnings made in the thirties. The punched card approach to statistical and research problems was started at a time when tabulating equipment was slow and relatively unsophisticated. Origin and destination data and similar tabulations useful for planning and for traffic engineering were among the first reports prepared.

Early in 1955 extensive efforts were started in order to produce a system of calculation to serve the design and construction engineer. Since that time the major portion of the processing volume has been concerned with traverse solutions earthwork quantity calculations, and vertical alignment problems. Other services which are being utilized by the engineer include structural analysis and design computations, traffic assignment, geodimeter traverses, and miscellaneous quantity calculations.



John A. Haller, Senior Research Technician, selects cards prior to processing. The IBM 650 console and power unit have the covers removed to show the intricate circuitry.

Advantages Cited

Some of the basic advantages frequently cited as resulting from the use of machine computations are savings in man-hours and money, increased accuracy, and neatly tabulated results. Probably the most important benefit, however, is the potential saving in engineering time, and this was the original primary objective when the feasibility of using tabulating equipment for engineering computations was first investigated. The extent to which these services have been used to reduce the number of repetitious calculations performed by the engineer, thereby leaving him more time for decisions requiring engineering judgment, would be a good measure of the effectiveness of the program.

The fact that at the present time over 300 miles of earthwork calculations, 125,000 traverse courses and numerous calculations involving vertical alignment data, structural design and analysis, traffic analysis, etc., are processed each month, provides some indication that this primary objective has been achieved.

As an aid toward promoting more efficient use of these services throughout the division, several districts have appointed engineers who act as co-ordinators for machine computations. These co-ordinators maintain contact with the Headquarters Design Section and Planning Survey and provide a readily available source of information to operating personnel in their respective districts. Being well versed in the capabilities and limitations of the various programs, the liaison man can be of valuable service to the district personnel in immediately resolving most problems concerning procedure. In this connection periodic visits by the co-ordinators and any other interested users of the service are welcomed by Headquarters Office personnel who are available to demonstrate the procedures and equipment and offer consultation in any matters regarding the data processing system.

Vertical Alignment

The most recent major service to be placed in production is the Profile Grade and Grid Elevation Computation Program. A service to calculate profile grade elevations only was placed in operation in 1957 and the

capability of obtaining grid elevations was introduced early in 1959.

This service consists of the determination of profile grade data or the computation of roadbed elevations anywhere on successive cross sections by combining profile grade, superelevation transition, and cross section data. In addition, the program can determine, as a separate problem, the transverse location of specified contour elevations on successive cross sections.

This computer service is used by design and construction engineers for the following applications:

1. To obtain profile grade line information.
2. To obtain elevations along pavement and shoulder edges.
3. To determine the location of, and the elevation of, sags and summits for drainage studies.
4. To obtain tabulations of specified contour elevations for plotting bridge deck contour maps or proposed roadway contour layouts.

These grid elevations determined by the electronic computer are forwarded to the engineer in neatly printed tabulations which he can use directly in the field or office. The listing is arranged in the conventional cross section note manner.

The program is being modified so that the output cards can be used directly as input roadbed template data to be combined with terrain data for the computation of earthwork quantities without the necessity of copying data by the engineer or repunching cards by the key punch operators.

Traverse Computations

The traverse solution program was the first of the various services to be offered to the districts on a production basis and it has proved to be the most widely accepted, as evidenced by comments from district personnel and by the fact that it is utilized by a greater number of operating units than any of the other programs.

One of the reasons for the popularity of this program is that the engineer is able to convert to the format used in submitting data for machine computation with little change from conventional manual traverse calculation methods. Another reason is that traverses are calculated and results mailed back to the district on the same day the problems are received at Headquarters Office. This will still result in some delay, however, and rearrangement of work schedules is sometimes necessary in order to utilize the service to the best advantage. The effect of this waiting period has been minimized with the introduction of interdependency between traverses which was made possible by the acquisition of computing equipment with greater capacity. This feature allows the engineer to call for and use results of the calculations of a particular traverse in a subsequent traverse without the necessity of waiting for the initial solution to be mailed back before submittal of the dependent traverse.

Real Traverses Few

Relatively few courses submitted are traverses per se. Most traverses submitted for solutions of unknowns are a variety of geometric problems such as are encountered in interchange areas for solving intersections of skewed structure bents with centerline or location of ramp noses. Traverses are used as a matter of convenience in lieu of the more cumbersome academic methods.

At present the following types of problems can be processed:

1. All sides and bearings known.
2. Any problem with two unknowns. These unknowns may be two distances, two bearings, or one distance and one bearing in either the same course or in different courses.
3. Traverse adjustment by either the compass or transit rules; and
4. Any of the problem types listed under 1, 2, and 3 above plus the enclosed area.

The final tabulation includes the following:

1. The original data;
2. The missing data for unknown courses;
3. The latitude and departure for each course;
4. The co-ordinates for each course;
5. The error of closure; and
6. When requested, the area enclosed by the traverse in square feet and acres.

Early in 1959 the program was refined and expanded, resulting in the following additional computer capabilities:

1. Descriptive data consisting of 14 alphabetical and/or numerical characters can be submitted and will be reproduced on the output tabulation;
2. Curve alignment consisting of either the radial bearing when when stationing is known, or stationing when the radial bearing is known, can be computed;
3. Dependency within the same traverse problem is possible;
4. Complete interdependency is possible regardless of the number of solutions;
5. Dependency between traverse and curve alignment problems is allowed; and,
6. Rotation of bearings up to 360 degrees in either direction can be accomplished.

Earthwork Quantity

In terms of tabulating man-hours and card volume, the earthwork program has been the major engineering computation project undertaken by the Planning Survey. This is due to a number of factors among which are inherently large amounts of input data, extensive preparatory card handling, a great deal of special handling, and the necessity for procedure writing in order to process district requests for manipulation of original data.

Shortly after the inception of the program late in 1955, it was realized that more powerful computing equipment would be necessary to handle the volume of work which could be anticipated at that time. Accordingly, an IBM type 650 computer was acquired by the Planning Survey. This change made it possible to obtain in one pass of the cards through the computer the same results which previously required over 60 card-handling steps. A great deal of input card handling is still necessary, with the result that earthwork calculations take considerably more time than any of the other services. It may take from 8 to 15 working days following receipt of data to process a complete earthwork project. The length of time

is dependent upon the amount of special handling required, coupled with the incidence of questionable data and upon existing workload in the tabulating section.

Notes Transmitted

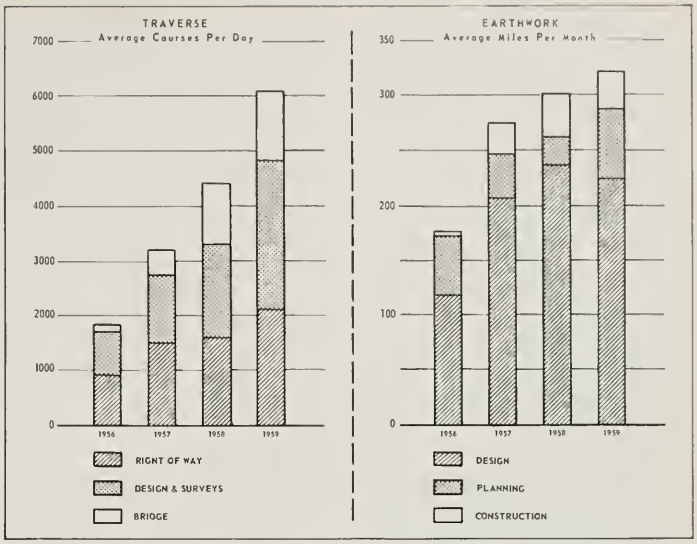
Under the present system, terrain notes are transmitted to the Planning Survey as they are written in the field or prepared from contour maps. Notes can be submitted in the form of true elevations, rod readings, or as differences from elevation at centerline or an offset point. Roadbed notes are submitted similarly. Cards are punched for roadbed and terrain notes separately, and each deck of cards is put in sequence and mechanically merged by station before processing through the computer.

The engineer is furnished with the following tabulated results:

1. A list of reduced terrain and roadbed notes;
2. A quantity sheet showing stationing, end areas in square feet, excavation and embankment quantities in cubic yards, grading factors and mass diagram ordinates by station; and,
3. A list of calculated slope stake points and side-slopes by station.

In addition to performing the basic quantity calculations using original notes, the data can be reused and manipulated in various ways without rekeypunching. Examples are horizontal and vertical grade shifts which can be performed mechanically upon receipt from the engineer of grade differences, or offset distances. Another example is the use of computing equipment to make terrain adjustments according to the method described by L. L. Funk in his paper published in *Highway Research Board Bulletin 228*, National Research Council, 1959, entitled "Terrain Data for Earthwork Quantities." The adjustment consists of raising or lowering the entire terrain at each cross section by an amount equal to the error at centerline. This operation can be performed upon the original terrain elevations provided the tabulating section is furnished with a list of adjustments.

The greatest saving in engineering manpower and money results from the use of mechanical methods to shift grades and from the reduction or elimination of cross section plotting and subsequent planimetering.



Traverse and earthwork computations processed by the Highway Planning Survey for the calendar years 1956 to 1959.

A recent innovation is the preparation of terrain notes from contour maps as described by Index Nos. 6-433.7 to 6-433.10 of the Planning Manual. This method utilizes either strips cut from a print of a map which includes photogrammetric cross sections (spot elevations) or a strip of transparent grid overlay which is placed over the contour map for entry of distances and elevations. Keypunching of terrain notes can then be performed directly from the strips by utilizing a special holder. The use of this method results in a savings of approximately two cents per point, which is roughly half the cost of transcribing notes by conventional methods.

Other Services

Another program available to the engineer is entitled "four-factor computation." This service will perform four types of algebraic manipulation involving four factors of six digits and will summate the results of any number of these separate calculations. The program is commonly used for clearing and grubbing computations, and for computing and summarizing construction estimate items.

The bridge design engineer may choose one of several tools for design and analysis work. Prominent among these tools is the column analysis program which will analyze any rectangular steel and concrete column for biaxial bending. The data submitted for this program consist of biaxial load, size of column, and position and size of reinforcing bars.

Another useful program designs a composite action steel and concrete girder from minimal data of span, spring, structure depth, and steel stress desired. This program also has the interesting feature of allowing the engineer to specify more than the minimum conformation so that individual requirements and decisions may override the standards built into the program.

Distribution Technique

Analyses of frames are made using a moment distribution technique. In this case, the computer is able to study many patterns in a comparatively short time by using iterative methods which are especially well accomplished by a computer. The multistory

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general frame analysis program computes final frame moments for a given set of loadings. Influence lines for single story frames, including as many as five spans, can also be computed. The Bridge Department has taken advantage of a synthetic computer language (Fortransit) to write single-use computer programs for the solution of special problems, such as tidal flow in Guadalupe Lagoon, and final design of the San Pedro-Terminal Island Bridge.

Other programs which have been written by the Bridge Department and which are in use by them, involve calculations for obtaining total settlement of bridge approach fills, volumes of excavation for bridge abutments and piers, and prestressed concrete girder design, including all properties of the section, plus the required prestressing force and resulting concrete stresses. A suspension bridge analysis program developed by the State of Washington was used in the design of the San Pedro Bridge.

Amounts of reinforcing steel in terms of length and weight are grouped by standard bar sizes, extended and summarized by means of another calculation service.

The Geodimeter program reduces Geodimeter Model 3 readings, checks for errors, applies necessary physical correction constants, and computes slopes and vertical and horizontal distances.

Traffic Problems

The IBM equipment is used extensively in the processing of rural and metropolitan origin and destination studies and in other traffic problems.

The conventional equipment is used to expand the sample interview data, whether it be roadside interviews or home interviews, to trips on an average weekday. The trip information is then processed to obtain the total transfer of trips between pairs of zones.

Proposed freeway bypasses in the rural areas or major city street and freeway networks in the urban areas are laid out on maps by the engineers. Trip volumes derived from the origin and destination studies are then routed over the bypass or freeway and city street network to determine the traffic profiles on the proposed roads and to obtain the turning movement for freeway access points.

The routing between pairs of zones has in the past been done manually. A method of routing trips mechanically selecting the route which is either the shortest in time or distance or some other criteria by use of the computer is being developed. This method will be made available for use as soon as it is fully checked, if it is found to be reliable. This would relieve the engineer of the tedious work involved in manual routings.

User Benefits Determined

The Freeway Assignment Program gives the necessary information to determine the user benefits if the bypass or network were placed in operation. This analysis is made for current-year traffic and generally estimates of traffic in the design year are made and traffic profiles and user benefits are determined for this year also. More than one design year and more than one freeway system may be studied for comparative purposes.

The estimated trips between zones for any future year are predicted by one of three methods now in use by Highway Planning Survey.

A multiple regression analysis develops the coefficients for the several components in each zone that have an effect on the volume of traffic. The coefficients developed for each zone are then used to predict traffic in the design year based on estimates of the predicting factors in the design year.

A second method, developed by personnel in District XI and called the Friction Factor Method, is used to estimate future trips between zones based on current trip ends per zone and estimated future trip ends per zone and the deterring factor of the distance between zones.

The third method, commonly known as the Frator Method, is based on current trip ends per zone and expected trip ends per zone in the design year, applying a method of successive approximation to distribute these trip ends from the subject zone to all other zones.

The computers and the other equipment are also used in the computation of average daily traffic figures from the annual and monthly count information, and to prepare the monthly traffic trend figures.

Annual tables summarizing traffic accidents by various categories are prepared for the Traffic Engineer.

A matrix solution service is available to solve simultaneous equations of 40th order or less.

The solution of various degree curves of best fit to a set of data is accomplished by use of a polynomial approximation program.

Multiple regression analysis is used for traffic studies and for materials and research laboratory problems. This service computes means, standard deviations, simple correlation coefficients, partial correlation coefficients and the residuals between observed and calculated values.

Time series trend equations are being solved for linear, semilog, and exponential values of Y (dependent variable) for years of trend plus desired years in the future, together with the standard error of estimate.

Extensive machine processing techniques are applied to data which are collected at various truck-weighing stations throughout the State. The information is gathered by Planning Survey field crews and includes truck weights by axle, commodities carried, vehicle dimensions, body types and age, and truck origins and destinations.

These data are checked for consistency, and grouped and summarized by tabulating equipment for aid in analysis. Annual tables are prepared from tabulations for the Bureau of Public Roads and include statistical summaries of axle frequencies, gross weights, number of trucks weighed and counted, numbers of trucks loaded and empty, percentages of trucks by type and percentages of each type occurring in the population which was sampled. By use of the computer, an annual table is obtained which summarizes the results of comparing various axle weight combinations against both state and AASHO overweight standards.

A monthly advance planning report and a weekly design section report are prepared for the Bridge Department.

Kern County

Two Freeways Completed Under County FAS Program

By WILLIAM CANESSA, Deputy Road Commissioner, Kern County

KERN COUNTY has recently completed two freeways. The first, on Federal-aid Secondary Route 887, was the Manor Street project, a 2.3-mile four-lane divided combination freeway and expressway connection between the northeast Bakersfield urban area and the unincorporated area of Oildale. This project starts at Union Avenue and the western end of Panorama Drive in Bakersfield on the bluffs overlooking the Kern River, and crosses the Kern River, its flood plain, two canals and connects with a four-lane divided highway at its temporary termini in Oildale. It eventually will be pushed to the north and west to connect with State Routes 142 and 129.

> "Kern County's planning for the future growth of the area adjacent to Bakersfield will help to avoid the costly and disruptive reconstruction usually associated with urbanization."
>
> J. C. WOMACK
> State Highway Engineer

The second freeway, on FAS Route 885, the Alfred Harrell Highway, begins at the eastern end of Panorama Drive in Bakersfield at the top of the same bluff on the south bank of the Kern River and proceeds up the river in a northeasterly direction for five miles. The work as completed to date has been constructed in two contracts. There will most likely be two and possibly three additional contracts let to complete this freeway from its present terminus to State Sign Route 178 approximately seven miles to the southeast.

Serves Recreation Area

This freeway serves as the only route to Kern County's largest recreational area, which includes an 18-hole golf course, a new 107-acre boating lake and Hart Memorial Park. Traffic counts are well in the thousands with weekend counts of over 15,000 and with proposed additional facilities and the natural expansion in that area even higher counts are expected.

The Manor Street project was completed under five separate contracts. The first was advertised in May 1954



Looking south at expressway portion of FAS Route 887 on Manor Street in Oildale, Kern County.



Interchange connecting Union Avenue (foreground) and Panorama Drive (right) in Bakersfield with Kern County's FAS Freeway to Oildale across Kern River (in distance).



Looking east toward end of Panorama Drive opposite Bakersfield College. Westbound traffic from Hart Memorial Park, destined for Bakersfield, travels Kern County's Alfred Harrell Freeway in distance at left and utilizes the old China Grade Loop Road to climb the Kern River Bluffs in foreground. The new down ramp for eastbound traffic is partly hidden by a bend in the bluff.



A "diamond" interchange on the Alfred Harrell Highway between Bakersfield and Hart Memorial Park.

and the last one completed in July 1958.

The first contract was the concrete pile-supported reinforced concrete "T" beam bridge 616 feet long spanning the Kern River. A second contract covered two smaller bridges and the roadwork. In November 1956 with the completion of the third contract which was the interchange on the south end, the road was opened to traffic as a two-lane highway. The traffic count on this road two weeks after opening was over 7,000 vehicles per day.

First Prestressed Bridge

The fourth contract covering structures for the northbound lanes included what is believed to be the first prestressed concrete bridge constructed in Kern County. The parallel structure for the southbound lanes was a composite steel beam with con-

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Oregon Trail

State's Longest FAS Route Is Being Relocated, Improved

By MELVIN E. DALE, Trinity County Road Commissioner and A. A. POWERS, Siskiyou County Road Commissioner

Construction of the Trinity Dam northeast of Weaverville in Trinity County has provided a welcome stimulus to much needed road construction on Federal-aid Secondary County Route 1089. This route is the only direct north-south connection between Weaverville, the county seat of Trinity County, and Siskiyou County points, measuring 124 miles, it is the longest continuous Federal-Aid County Route in the State.

This route has a long if somewhat obscure history. It is, in part, the historic "California-Oregon Trail" which extended from Shasta, the early day metropolis of Northern California, through French Gulch and Trinity Center, thence north into Scott Valley and Yreka. Over it passed the first north and south stage travel, which was greatly increased after 1849 by the discovery of gold.

With the exception of necessary maintenance, little construction was done on this route prior to the beginning of the Federal-Aid Secondary Program in 1945. Under this program 14 contracts, comprising work by 12 different contractors, have been completed. These contracts have provided 40 miles of road, graded and surfaced to modern standards, and the replacement of eight obsolete bridges.



A recently improved Section on FAS 1089 at the south end of Scott Valley in Siskiyou County.

Further Progress Mode

Through the combined efforts of the U.S. Bureau of Reclamation and Trinity County, further strides are being made in the reconstruction of the southern portion of this highway. The U.S. Bureau of Reclamation is constructing new portions of Route 1089 around the west side of Trinity Lake to replace roads which will be inundated by the construction of Trinity Dam. Trinity County is reconstructing intervening portions.

Construction in Trinity County, including surfacing, is scheduled for completion as far Carrville at the upper end of Trinity Lake by 1961. A stretch of 40 miles of modern highway from Weaverville north will then be ready for use by the traveling public. From Carrville to the Trinity-Siskiyou County line near Scott Mountain, construction will be somewhat slower due to the very rugged terrain and the bridges required to span the many mountain streams emptying into the Trinity River. This remaining 18 miles of road in Trinity County is unimproved, with a number of sharp curves and steep grades. In general, it is wide enough for two lanes of traffic and readily traversable except in the winter months.

Road Crosses Pass

At the Trinity-Siskiyou County line the road crosses through a pass near the summit of Scott Mountain at an elevation of 5,350 feet and descends to the floor of Scott Valley near Callahan at an elevation of approximately 3,000 feet. This section of road is also unimproved and comparable to the section on the Trinity County side of the pass.

From Callahan to State Highway Route 82 at Etna, a distance of about 14 miles, four FAS projects have been completed and one is now under contract. Upon its completion in 1960, the entire section of FAS Route 1089 between Callahan and Etna will have been graded and realigned to modern standards with bituminous surfacing throughout.

Between Etna and Fort Jones, traffic follows State Route 82 along the westerly side of the valley eight miles to Greenview, from where it crosses the valley to Fort Jones about six miles away.

A project for reconstruction of FAS Route 1089 between Fort Jones and six miles northwesterly was completed several years ago. The remaining 24 miles, which follows closely the Scott River to connect with the Klamath River Highway near Scott Bar, is unimproved but easily traversable except in bad weather.

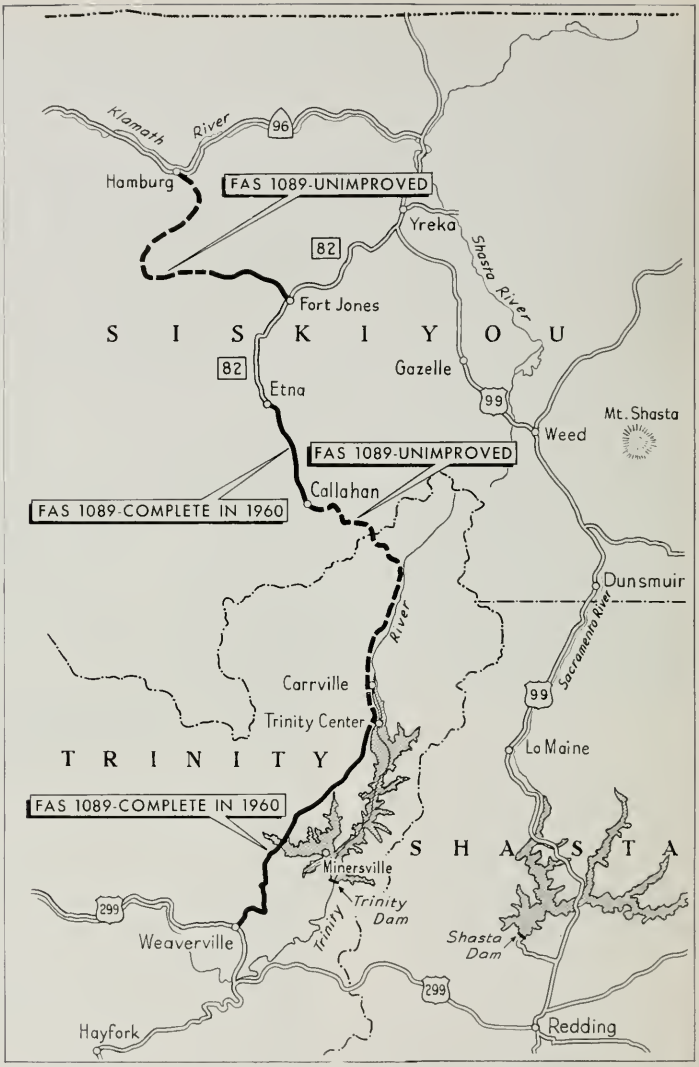
Many Attractions

This increasingly popular route will hold many attractions for the motorist. A short side trip will take the traveler to the site of the Trinity Dam. This dam, scheduled for completion in 1961, will be the highest earthfill dam in the world, rising almost 500 feet above streambed. The mountain lake formed by the dam will have a surface area of approximately 25 square miles. From about 10 miles north of Weaverville to Carrville the relocated FAS Route 1089 will be, in general, a lakeshore road skirting the wooded shoreline of the lake for many miles and affording many scenic views of lake and mountains.

All of the mileage in Trinity County is in mountainous country, cutting through the heart of the beautiful Trinity Alps, and giving access to vast primitive recreational areas. West of the road the Salmon Trinity Alps Wilderness area lies ready for exploration by the more hardy and adventurous. To the east lies a vast stretch of mountains threaded with many streams and dotted with numerous lakes all of which are capable of affording excellent sport for the fisherman. Public camps are positioned along the road and can be used as a base of operations for jeep or hiking trips into the mountains.

Vast Forest Areas

Cattle ranching and farming are the main pursuits in Scott Valley in Siskiyou County. West of Scott Valley vast areas of federal forest are beginning to supply timber to lumber mills in Scott Valley, Yreka and Weed. It is estimated that the annual cut will amount to over 50 million board feet in the near future. In the area southwest of Callahan beyond Cecilville approximately 3.5 billion feet of prime timber is available, all of which will be transported over county and state roads.



The above map shows the present status of improvements to Federal-aid Secondary Highway Route 1089 consisting of Trinity and Siskiyou County roads connecting with state highways at Weaverville, Fort Jones and the Klamath River. The portion between Carrville and Callahan follows the original "California-Oregon Troil." The route between Weoverville and Yreka conforms in general to the legislative description of a route in the future California Freeway System.

North of Fort Jones, Route 1089 parallels the scenic Scott River noted for its fine trout and steelhead fishing. West of this section the Marble Mountain Wilderness area, one of the nation's largest unspoiled primitive areas, is available for pack trips, hiking, fishing, and hunting.

The increasing importance of this

. . . Continued on page 63



Deck grinding operotion on new 394-foot bridge across moin wash of Red Rock Canyon. Striped cliffs in backgraund are site of annual Easter sunrise services.

Red Rock Canyon

Two-year Reconstruction On US 6 Is Completed

By C. E. FORBES, Resident Engineer

Completion of the second major contract in two years on U.S. Route 6, in Red Rock Canyon, concludes the elimination of a historic "bottleneck" between Southern California and the "High Sierra" area.

Red Rock Canyon, located approximately 25 miles north of Mojave, California, has been the scene of numerous destructive flash floods resulting in complete road closures for short periods, and one-way traffic for as long as two months. The watershed area of the canyon consists of approximately 47 square miles of steep terrain almost bare of any vegetation. During the last major flood, in October 1945, a momentary peak flow of 16,000 second-feet was realized. This same flood resulted in a complete road closure for 48 hours and one-way traffic for two months. To bypass Red Rock Canyon a detour of some 50 miles via US 395 and US 466 is necessary, since the only other through route in the area is via a county road which also crosses the wash.

Parallels Wash

The original highway paralleled the main wash for about three miles and crossed it via dip sections at three locations. Numerous lesser washes also contributed to the flooding problem.

Aside from vulnerability to washouts the original route contained many severe sight restrictions, both vertical and horizontal, which, coupled with steep grades and 15 percent truck traffic, made a slow and dangerous stretch in an otherwise high-speed highway.

U. S. Route 6 is the shortest route between Southern California and the Rocky Mountain areas, as well as the recreational facilities of the eastern Sierra region. It is also an important outlet for the U.S. Naval Ordnance Test Station at China Lake near Ridgecrest, and for chemical installations in and near Trona and the Searles Lake area. An ever-increasing amount of truck traffic follows US 6 to Bishop then US 395 to the Pacific Northwest.

The bond issue of 1919 provided for the completion of a highway from Bishop to Los Angeles, and the existing route was taken into the state highway system in 1925. It was not until 1930, however, when a 15-mile contract was let to George Herz & Co., from Cinco to seven miles north of Ricardo through Red Rock Canyon that this vital link in the highway system was completed.

Scenic Beauty

The Red Rock Canyon area is in itself a tourist attraction for its scenic beauty and is somewhat of a "paradise" for "rock hounds," photographers, and amateur prospectors. Many campsites are available, and campers are seen even in the hot summer months. The area is also well known for its use as an outdoor studio in countless western movies and TV shows.

The first of the two recent contracts consisted of reconstruction generally along the existing alignment through the narrowest part of the wash. This project extended from the mouth of the canyon for approximately one mile north with a temporary connection at the north end. To provide adequate sight distance a 60-foot all-paved section was constructed with minor relocations to provide for 60-mph alignment. The widening and realigning from the original winding two-lane road necessitated extensive channel changes which accounted for the bulk of the grading and over half the cost of this contract.



Old highway crossing of the main wash of Red Rock Canyon in dip section where flash floods frequently closed the road. This is site of new 13-span, four-lane concrete bridge.



New bridge across main wash of Red Rock Canyon during construction. Note sand fill used instead of conventional falsework for deck slab.

During construction it was found that the fractured rock in the channel cuts was unstable on the planned ½:1 slopes and several slides occurred, making it necessary to flatten these slopes to ¾:1. The ditch and channel excavation along with roadway excavation provided material for the roadway embankment and the excess was stockpiled for use as untreated base and mineral aggregate for plant-mixed surfacing on this and the second contract.

Embankment Protected

To protect the embankment adjacent to the realigned channel, grouted rock slope protection was placed to within about five feet of the finished shoulder. The grouted rock was placed in a mat two feet thick measured normal to the slope.

The placing of rock slope protection preparatory to grouting was completed on September 5, 1958, and on September 6, 1958, a flood occurred in the channel which washed out a section of the ungrouted rock and washed sand and mud into the remainder of the rock for heights varying from 4 to 12 feet. This delayed the start of grouting operations by five weeks.

A second flood occurred on October 24, 1958, after most of the grouting was completed and damage was confined to a short section of ungrouted rock and to washing out the concrete batch plant.

This contract was completed on November 24, 1958, by Stecker & Scott & Spirite & Conn at a cost of approximately $460,000. D. A. Crane was resident engineer for the State.

Complete Relocation

Work on the second contract got under way in April 1959 and except for the two ends was a complete relocation primarily to the east of the old highway. This section picked up where the other ended continuing the 60-foot all-paved section across the main wash on a 394-foot reinforced concrete slab bridge consisting of 13 spans supported on concrete pile bents. After crossing the wash the roadway transitions into District IX's first full divided highway with a 22-foot median. The new alignment avoids recrossing the main wash, remaining to the east with the aid of extensive channel excavating for approximately one mile before swinging completely out of the main wash area. The divided highway runs for two miles before it transitions back into

two lanes for the last mile tying into the existing road about 4½ miles north of the mouth of the canyon.

After leaving the main wash area the new alignment crosses one of the major tributaries to Red Rock Canyon at three locations. This wash drains an area of some 16 square miles, and has an estimated maximum flow of 830 second-feet; 556 lineal feet of 108-inch field assembled plate culvert were used in these three crossings.

Use Wooden Forms

All work on the bridge was completed on the job site. The contractor set up a pile casting yard and cast the 6,150 lineal feet of concrete piling using wooden forms. The usual procedure was to cast 8 to 10 piles per day, stripping and reforming for the next pour the following morning; 142 piles were poured in this manner. Pile driving was accomplished with a combination of jetting and driving with a diesel hammer.

In lieu of conventional falsework for the bridge deck, the contractor used a sand fill placed by rubber tired scrapers and dozers after pile driving was completed. The sand fill was fine-graded by hand and one-fourth inch plywood nailed to 2 x 4 sills was used to form the soffit for the deck slab. The sand fill was removed by skip loaders after waiting vainly several weeks for a flood to come along and wash it out.

Upon removal of the sand blanket, used in curing the deck concrete, it was found that the finished deck did not meet the smoothness requirements. The contractor elected grinding as a corrective measure.

Deck Is Smoothed

A Concut Bump Cutter was obtained to plane the entire deck thereby improving both the appearance and the riding quality of the bridge and bringing the work within the permissible tolerance for smoothness.

Grouted imported rock protection was also used on this project with the rock being placed with a "Gradall" which eliminated the need for all but very little hand labor. Grouted rock slope protection was used on the embankments adjacent to the wash, at each side of the south bridge abutment, and at the inlets and outlets of the 108-inch field assembled plate culverts.

Due to limited headroom and close spacing of piles it was impractical to place rock and grout beneath the bridge at the south abutment. Here slope protection was provided by placing a four-inch mat of Gunite reinforced with 4" x 4" steel mesh to a depth of 12 feet below channel grade.

The second contract was completed on February 3, 1960, by R. R. Hensler, Inc., at a cost of approximately $700,000. C. E. Forbes and M. D. Tetrick were resident engineers on this contract. An interesting note is the fact that both jobs were supervised for different contractors by the same superintendent, Mr. Ray Mason.

When coupled with a previous project to the south, completion of this work gives the district its longest continuous four-lane highway, seven miles. The two contracts combined, consisted of 735,700 cubic yards of ditch and channel and roadway excavation and 26,400 cubic yards of grouted rock slope protection.

All work was under the general supervision of District Construction Engineer J. R. Jarvis and District Engineer E. R. Foley.



New realigned four-lane section climbing out of main wash of Red Rock Canyon. The grouted rock slope protection extends 12 feet below the interception channel.

US 101 in Ventura Will Be Six-laned

The State Department of Public Works today has awarded an $8,209,756 contract to Griffith Company, Los Angeles, for grading and surfacing 4.6 miles of six-lane freeway on US 101 between Telephone Road and Palm Street in and near Ventura.

Ten structures will be built, including traffic separation bridges, a pedestrian overcrossing, and railroad grade separation structures.

Resident Engineer in District XI Retires

William T. Rhodes, long-time Resident Engineer for the California State Division of Highways in the San Diego area, retired on February 1. Rhodes, who was employed by the State for 39 years, acted as the State's representative on numerous construction projects both in the central as well as the southern portion of the



William T. Rhodes (right) with E. E. Wallace, retired District Engineer of District XI.

State. During his career, he developed a number of aids to the field of Highway Engineering. Among them the "Rhodes Arc," which rapidly calculates the relationship of Horizontal to Slope distance for surveyors, is the widest used. Other innovations have been "Rhodes Ready Reckoner" for determining pavement depth during construction, and "Rhodes Temporary Striping" consisting of white painted tar paper which is glued to new paving with asphalt binder to delineate traffic lanes through new construction.

Rhodes participated in highway development and growth during its greatest period of change and has supervised construction projects ranging from two-lane desert highways to the complex US 80 Freeway between Grossmont Summit east of La Mesa to Chase Avenue in El Cajon.

On retirement, Rhodes and his wife, Marguerite, plan an extended trailer tour. They will maintain their residence in San Diego.

KERN COUNTY

Continued from page 44 . . .

crete deck, but due to a steel shortage it was decided to use the prestressed concrete channel type for the second structure.

The fifth and final contract to complete the four-lane divided road was accepted in July 1958.

The total cost of the 2.3-mile Manor Street Freeway-expressway, not including expenditures for right-of-way or engineering, was approximately $971,600. The roadway is plant-mixed surfacing over eight inches of Class "C" cement-treated base with curbs and gutters for drainage and traffic control. The roadbed was constructed with a core consisting of sand from the Kern River and the outside 12 feet and top 2.5 feet with a select material obtained from a borrow pit adjacent to the south end of the job. The reason for this is evident since the sand was in the middle of the project and next to the road, which made the sand borrow economical. The facing material was necessary since the embankment would be subject to washing or scouring when the Kern River overflows into the flood plain.

South End Interchange

Another interesting feature of this project was the construction of the interchange at the south end. This interchange was constructed in an abandoned borrow pit where 80-foot cuts were involved and, 150 feet away, 44-foot fills were required.

The Alfred Harrell Highway freeway begins on top of the bluffs and consists of a one-way down ramp and a one-way up ramp that are separated by a vertical distance of about 350 feet. The west ends of the two-ramp are one-half mile apart but are connected at the bottom by an interchange. The old two-way China grade serves as the one-way up ramp.

The continuation of this freeway to the west entrance of Hart Park was completed in August of 1959. This last contract was four miles long and had two complete interchanges with necessary frontage roads for access to all properties. The total cost of the work done to date on this project, not including engineering or right-of-way, is $1,024,000 for about five miles of freeway. This roadway is three inches of plant-mixed surfacing over 6 inches of cement treated base with curbs and gutters at interchanges for drainage and traffic control.

The proposed freeway extension will include at least three additional interchanges and possibly four. There are three interchanges on the completed portion.

State Awards Contracts

As required under the federal-aid secondary highway program all contracts were awarded by the State Department of Public Works. Federal funds were provided through the U.S. Bureau of Public Roads and the State Division of Highways. A portion of the matching moneys consisted of state highway funds which, along with the federal funds were apportioned to Kern County in accordance with state statutes. A substantial portion of the matching funds were provided by the county.

The resident engineer on all the contracts except the first bridge contract on Manor Street was Charles M. Call. The resident on the first bridge contract was George J. Hummel. These projects were designed, engineered, and inspected with county personnel all under the general direction of Vernon G. Smith, Road Commissioner. The Kern County Board of Supervisors co-operated with the planning and financing of these projects.

La Forge Honored by County Engineer

At the California County Engineers Association annual dinner this year in Los Angeles, California Division of Highways Principal Engineer Harold B. La Forge was honored in a surprise ceremony. La Forge, who has been in charge of the Division's Federal Secondary Roads program since 1945, was presented with a gift subscribed to by the entire membership. Association President R. P. O'Neill of Butte County praised the Division of Highways engineer for the excellent relationships he has maintained during his 15 years on the job.

Profilograph—2

History of Measuring Devices In California Is Described

By FRANCIS N. HVEEM, Materials and Research Engineer

THE CALIFORNIA DIVISION OF HIGHWAYS became interested in means for evaluating road roughness more than 30 years ago, and for many years construction forces, resident engineers and contractors were "kept on their toes" by the fact that pavements would be evaluated for roughness at the completion of the contract. The devices used were of the type described previously in the form of a mechanically operated counter actuated by the movements of the front axle of a car. (Figs. 16, 17, 18.) In 1950, the mechanical difficulties of the car-mounted Roughometer were overcome by the development of an electronic device, but differences between cars still affect the readings.

This article is the second of two describing the development of use of devices for measuring the roughness of pavement. This material was also presented before the Highway Research Board at its 39th Annual Meeting in Washington, D.C., January 11 to 15.

A novel instrument developed by E. L. Seitz, Resident Engineer of the California Division of Highways,[1] is the Bumpograph (Fig. 19) which was intended solely for use during the construction of asphaltic concrete pavements. When wheeled by hand over a section of pavement, the Bumpograph would mark all of the high spots with white chalk. The machine was light in weight, weighing only about 30 pounds and had a wheelbase of approximately eight feet.

While serving as a resident engineer on a paving contract, the author developed a simple profile measuring device which it now appears was identical in principle to the original Viagraph ascribed to Mr. Brown of Belfast 40 years earlier. The mech-

[1] *California Highways and Public Works*, February 1937, page 26.

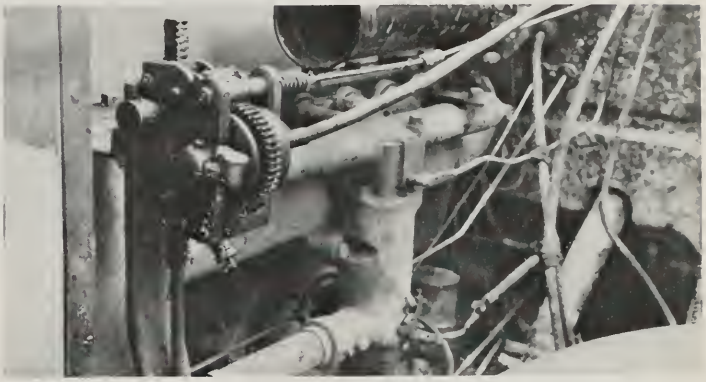


FIGURE 16—Shown above is the method of mounting the Roughometer rack and roller on an automobile.

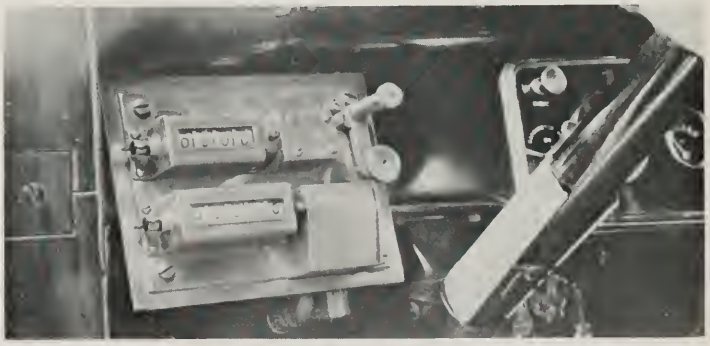


FIGURE 17—The Roughometer shown mounted on the instrument board of an auto.

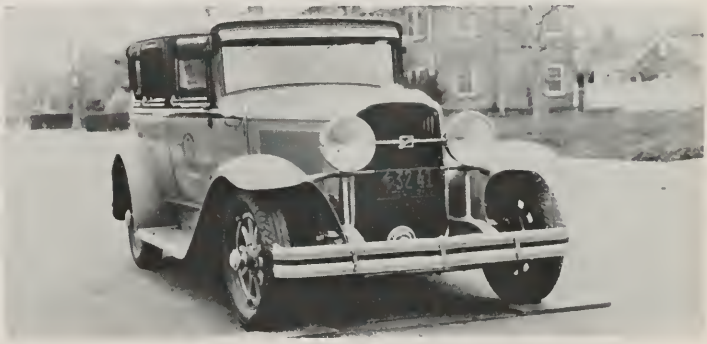


FIGURE 18—Testing the Roughometer with one-inch boards—1931.

anism used, however, was much less involved than that shown for Brown's Viagraph. The straightedge was constructed of two pieces of 1" x 6" lumber 10' in length. The paper feed roller was driven by a small rubber-tired wheel and the mechanism taken from a small hand-operated churn served as a reduction gear. The stylus was a common lead pencil and the platen supporting the paper was an empty tomato can. Graph records were quite accurate and reproducible. However, the unit was somewhat noisy in operation and dragging the "sled" for any appreciable distance became a little wearing.



FIGURE 19—The Bumpagraph, shown above, was constructed by E. L. Seitz, of the California Division of Highways, for detecting bumps during construction of asphaltic pavement.

First in California

In 1940, after becoming associated with the Materials and Research Department, a more elaborate device was constructed (Fig. 20), which consisted of a frame 10 feet in length supported upon multiple wheels at either end. The important feature of this first California profilograph[2] is the fact that the frame could be broken down into relatively small pieces for ready transportation in a pickup or in the tonneau of a small sedan. The selection of a 10-foot length of frame was due to the fact that California specifications for pavement finish referred to the amount of departure from a 10-foot straightedge placed on the surface. Profilograms obtained with this profilograph were compared with profiles plotted from level notes at five-foot intervals and also comparisons were made over sections of pavement by stretching a steel piano wire and measuring ordinates with a steel scale (Fig. 21). Agreement appeared to be sufficiently close for all practical purposes but unanswered questions always persisted as to the exact shape of the bumps in the pavement.

[2] *California Highways and Public Works*, March-April 1944, pp. 6-9.

Longer Base Needed

With the general increase in the speed of traffic and trend toward vehicles with a longer wheelbase, it was concluded that an improved profilograph should have a longer frame and a 25-foot length was selected more or less arbitrarily. Experience in operating the hand-propelled profilograph on pavements subjected to high speed traffic has shown that this is definitely a hazardous occupation. Therefore steps were taken to develop a unit capable of more rapid operation and which would offer reasonable protection to the operator. In order to accomplish both purposes a profilograph mechanism was incorporated into a two-ton truck. The frame of the truck was lengthened and became the principal "beam" member. The truck was equipped with a series of small bogie wheels in the front and rear making a total of 10 wheels in line. Figure 22 shows this truck with the operator carried by an independently supported frame pushed ahead of the truck; this position enables him to get a close view of any cracks or defects which are registered on the profilogram by manually pressing appropriate buttons on the console. Figure 23 shows the unit with the driver in an elevated position back of the cab. This position is used whenever it is not necessary to mark cracks or joints on the profilogram. The vertical movement of the extra bogie wheels is mechanically integrated and then electrically integrated with the movement of the truck frame in order to produce a datum representing the mean elevation of the high or low spots of the pavement which are in contact with the 10 wheels.



FIGURE 20—The multiwheel profilograph with 10-foot base length developed by the California Division of Highways.

Vertical Motion Recorded

The "profile" is recorded from the vertical movement of a wheel attached

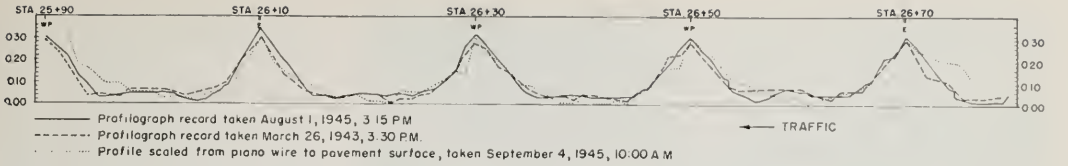


FIGURE 21—The above graph shows the relative accuracy of profilograph records compared with a profile obtained by stretching a piano wire and scaling off set to pavement surface. The pavement shown is a badly curved or warped concrete pavement.

to the truck frame at the midpoint and is always with reference to the mean elevation of 10 points of contact with the road surface. This self-powered mobile profilograph was constructed in 1955 and has been operated over the length and breadth of California and was sent on one trip to Colorado to record the riding qualities produced with a slip form type of paver. This truck model has proved to be eminently satisfactory and has given little or no trouble in operation and has enabled us to make records over many miles of existing highways. This unit has been duplicated with some modifications in the State of Michigan and reported by William S. Housel and Olaf L. Stokstad in a paper entitled "Pavement Profile Surveys to Correlate Michigan Design Practice With Service Behavior." [3] It has permitted setting up of a tentative scale for evaluating pavement roughness and relating this scale to the so-called riding qualities or the reactions to road roughness of drivers and passengers in motor vehicles.

[3] Proceedings of the 38th Annual Meeting of the Highway Research Board, Vol. 38 (1959).

While the truck-mounted profilograph is invaluable for securing measurements over many miles of an existing highway system and for following the changes that take place with time and traffic, it is, of course, not suitable for use on jobs under construction. The truck is obviously too heavy for safe application on a newly constructed concrete pavement. Therefore, there is a need for a lightweight profilograph and a new model has been constructed using the same wheelbase as the truck unit and which produces a graph record by mechanical means that is virtually identical.

Unit Too Light

There had been some complaint from operators using the original small plywood unit that crosswinds at times created problems in operating the machine. Therefore, a 25-foot unit using a tubular aluminum frame was constructed in an attempt to meet this objection (Fig. 24). While satisfactory so far as operation and ability to knock down and reassemble the tubular frame, this material and type of construction proved to be relatively expensive and so in 1957 another hand-propelled model was designed using a plywood frame constructed in five sections for ready knockdown and transportation (Fig. 25). This model, constructed of plywood, appears to be superior in most respects considering rigidity, ability to nest units for conservation of space in a transporting vehicle, enclosing of the operating mechanism for protection against damage and above all the lowest initial cost of construction. This instrument is intended primarily for use to check the surface roughness of newly constructed pavements. The profile of the finished pavement is recorded on a graph record or profilogram to a horizontal scale of one inch equals 25 feet and a vertical scale of one inch equals one inch which is the same as the scale established for the mobile truck-mounted unit.

Number System Evolved

Since the first roughness measurement devices were constructed, there has been an instinctive and virtually automatic move on the part of en-



FIGURE 22—A mobile profilograph constructed by the California Division of Highways in 1955 showing the operator in position to record cracks and joints.



FIGURE 23—The profilograph in Figure 22 showing the recording console in the elevated position.



FIGURE 24—A hand-propelled profilograph with unitized frame for rapid knockdown.



FIGURE 25—The most recent model of a hand-propelled recording profilograph intended primarily for construction control.

gineers to reduce the data to a number. For example, in the report of Mr. Brown's Viagraph it is shown that he recorded a profilogram and he also expressed road roughness in terms of feet per mile. It is previously noted that he thought that 15 feet of roughness per mile represented a very satisfactory road! Throughout the years, engineers have converted the readings of roughometers, profilometers, etc., to numbers, thus California employed a unit of inches per mile to express results of a "bumpmeter" mounted in an automobile.

The Bureau of Public Roads device has means for integrating the results, and Professor Housel has added a mechanism for accumulating the total distance involved in the vertical excursions of the recording stylus to develop a "roughness index." It is true, of course, that these numbers are convenient, but unfortunately often represent an oversimplification and no simple numerical scale has been devised to distinguish between large numbers of small asperities on the pavement surface as compared to a few larger and distinct bumps. The British machine uses a number of different counters but the results are not expressed by a single number. It appears that there is no substitute for a careful examination of the graph record if an engineer wishes to know what is going on during construction of a pavement or to study the nature of changes which are taking place with time and traffic. However, the use of a roughness "number" becomes less objectionable and is more justifiable as a means for specifying the surface finish to be obtained during construction.

New Index Made

Therefore, California has developed a new index which has been called the "profile index" to indicate that it is derived from the recorded profile or profilogram record. Appendix I, attached herewith, is taken from a report by Mr. Bailey Tremper describing in some detail how the profile index was derived. No claim is made that the roughness or riding quality of a pavement is directly or completely reflected by the profile index. It should again be emphasized that strictly speaking the devices reported herein do not furnish a direct index to "riding qualities." The most elaborate attempt to actually evaluate the response of a passenger is an elaborate instrument developed in Kentucky.[4] California duplicated the Kentucky machine and instrumentation but we were unable to interpret the results to give consistent or meaningful indices to rideability of a road surface. However, as a practical matter, it can be shown that if the profile index is very low the pavements are usually considered to be smooth and to have good riding qualities. At the present time California has established a profile index of seven which means that the contractor is permitted deviations outside of the 0.2 in. band which will not total over seven inches per mile or in proportion for shorter distances. A copy of our current specifications appears at the end of this article as Appendix II.

Cannot Differentiate

While the profile index appears to be reasonably satisfactory for use in specifications, it fails to differentiate between bumps or irregularities of different shape and of different length and this numerical expression does not adequately emphasive the annoyance in terms of riding qualities generated by badly faulted concrete pavement, for example. A somewhat more elaborate system of deriving a numerical index will be necessary if it becomes important to assign num-

[4] "Triaxial Acceleration Analysis Applied to the Evaluation of Pavement Riding Qualities," Gregg, L. E. and Foy, W. S., Kentucky Department of Highways.

bers to existing highways or airfields. It is to be doubted that there will ever be any adequate substitute for careful visual examination of the recorded profiles which convey information on the frequency, magnitude and shape of the inequalities, and it seems unlikely that all of these factors can be adequately identified by any simple numerical expression even tho the numbers are produced by feeding the profile record into one of the modern electronic calculators or data reduction "mechanical brains."

In order to illustrate some of the relationships and information which may be derived from pavement surface profilograms, several examples are shown. Figure 26 represents three profiles taken of the same stretch of pavement plotted by different means. Profile (a) was developed from level notes with rod readings taken at 2½-foot intervals. The readings were adjusted to eliminate any effects of pavement grade or grade changes. Profile (b) is the same surface as recorded with a truckmounted profilometer (Fig. 22, 23). Profile (c) is recorded with a hand-propelled model illustrated in Figure 24. Figure 26 and Figure 21 both demonstrate the relative accuracy of these profilograms compared to other methods of measurement.

Some Variation

It will be obvious, of course, that the inequalities in the pavement are recorded with reference to the datum furnished by a 25-foot beam supported on multiple wheels at either end. In order to illustrate the effects of varying the length of the wheel base, Figure 27 shows a stretch of concrete pavement with marked faulting at most of the joints as recorded by the 25-foot truckprofilograph. The succeeding profiles represent the same stretch of pavement recorded with hand-propelled units in which the length of wheel base has been changed successively from 25 feet to 20 feet, 15 feet and 10 feet respectively.

It will be evident that while there is not much difference between a 20-foot and 25-foot length, the 10-foot wheel base does introduce some departures in the recorded profile. It will be noted, however, that the principal features are shown on all records, especially the magnitude of faulting at the joints. Figure 28 is included to illustrate some of the changes in surface roughness which may develop in a pavement over a period of time. Here are shown three stages in the life of a concrete pavement; namely, after four months, one year and three years. Figure 29 illustrates the improvement in riding qualities that develop from placing successive layers of construction. The lower graph is the surface of a cement treated base. The second is the surface of the first layer or leveling course of asphaltic concrete. Third represents the second layer of dense graded asphaltic mixture and the fourth or upper profile represents the finished surface of an open-graded wearing course. It will be observed that while most of the initial bumps were eliminated in the top course, nevertheless, the principal one which is shown is apparently the reflection of a bump in the base course.

Faulting Detected

One valuable attribute of the profilograph is the ability to detect incipient faulting. If the instrument is adjusted to give the proper sensitivity, it is possible to estimate faulting to the nearest 0.01 inch. Periodic measurements make it possible to follow the increase in faulting if it occurs. Faulting can be detected on a profilogram before it is apparent from an inspection of the pavement. Profilograms provide a convenient method for recording the location of cracks and also for determining whether there is any relationship between the high or low points in the profile and the location of joints or cracks in the pavement. Profilograms have been used to measure the warping or curling of slabs as affected by variables such as the maximum size of aggregate or nature of the cement. For example, Figure 30 shows several profiles taken from the Topeka test road illustrating some of these effects. (Note that the numerical values for roughness represent a total range from high to low points and on this chart do not correspond to the profile index scale.) Profilograms have made it possible to visualize the wide variations in curling of concrete slabs that often develop between early morning and late afternoon. They have also demonstrated that California pavement slabs as a rule are curled upward at the ends and it is only on warm afternoons that the slabs approach a condition of flatness. Very few examples have been found of pavements that assume a downward curl with the joints being low.

Profilograms furnish an invaluable means for recording the initial roughness of pavements as constructed and for following up and analyzing the changes which take place during the years following construction. It is axiomatic that if an engineer is to take steps to correct any deficiency he must understand the nature and cause of the thing he is trying to correct.

Acknowledgments

I wish to acknowledge the contributions of many individuals who have furnished information and material used in this paper and to those who have assisted in the development and use of the profilograph units constructed in this State.

Among those who have furnished helpful information are:

Mr. H. Petersen, Road Research Institute, Technical University, Hanover, Germany.

Mr. R. Peltier, Director of Research and Tests, Laboratoire Central des Ponts et Chaussees, Paris, France.

Mr. A. C. Whiffen, Head of Special Problems Section, Road Research Laboratory, Harmondsworth, Middlesex, England.

Mr. J. D. Lindsay, Engineer of Materials, Division of Highways, Springfield, Illinois.

Mr. W. N. Carey, Jr., Chief Engineer for Research, and Mr. A. C. Benkelman, Flexible Pavement Research Engineer, AASHO Road Test, Ottawa, Illinois.

Professor Ralph A. Moyer, University of California, Berkeley, California.

Among those who have made contributions to the work in this State are:

Mr. Bailey Tremper, Supervising Materials and Research Engineer; Mr. George Pomeroy and Mr. R. E. Wil-

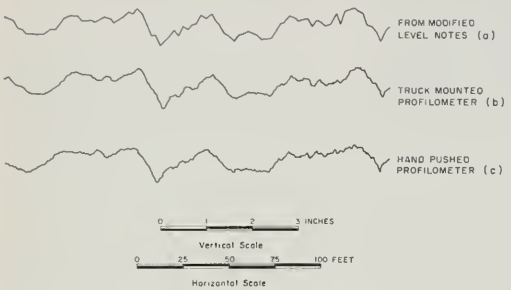


FIGURE 26—A comparison between three different methods of recording pavement roughness.

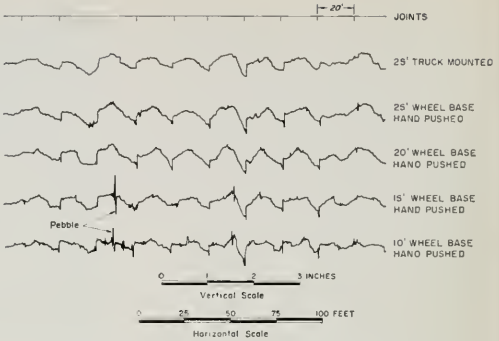


FIGURE 27—Profiles of a faulted concrete pavement showing influence of varying the length of wheelbase on the profilagraph.

helmy, Chief Instrumentmakers; Mr. J. L. Beatty, Mr. Charles W. Clawson and Mr. Douglas Howard who have operated the profilographs over many miles of road.

Mr. J. E. Barton, who suggested the electrical circuits making possible the compensating device on the truck-mounted profilograph, and Mr. Robert Field, who worked out the mechanical and electrical circuits for this unit.

Mr. Don Spellman, who developed the profile index.

Appendix I

MEASURING PAVEMENT ROUGHNESS FROM PROFILOGRAMS

During the spring and summer of 1956, profilograms of selected pavements in the nine districts were recorded with the new truck-mounted profilograph. These pavements were selected by the districts in response to a request for examples of "smooth" and "rough riding" pavements, of both portland cement concrete and bituminous types. The profiles covered 60 miles in all representing 17 sections of each type. Some sections were two-lane and others four-lane and since profiles were nearly always made of the two outer lanes, the lengths given above are only about one-half the total profiles obtained. All profiles represent the outer wheel track, about 30 inches from the edge of the pavement, recorded in the direction of traffic. From this group, 15 sections of portland cement concrete pavement and 11 sections of bituminous pavement were selected for study.

At the time the profiles were made, the operators recorded their personal observations as to relative roughness when driving over the roadway in a car. Disagreement in terms of personal impressions was found with only a few of the district ratings. Such disagreement, however, was only to be expected since the profilograph operators were making comparisons on a statewide basis, while the districts were presumably comparing roads within their own areas. It is believed that the observations made by the headquarters profilograph operators should be more consistent on a statewide basis and for this reason they are used in the discussion that follows.

The classification as to riding comfort must necessarily be broad because in addition to the factor of personal reactions, speed and type of vehicle are other prominent variables. Nevertheless, among the pavements selected, examples were found that could be classified as distinctly either rough or smooth without much likelihood of

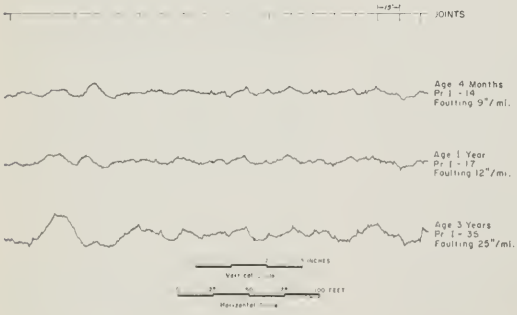


FIGURE 28—The three recorded lines above show the progressive roughening of a concrete pavement.

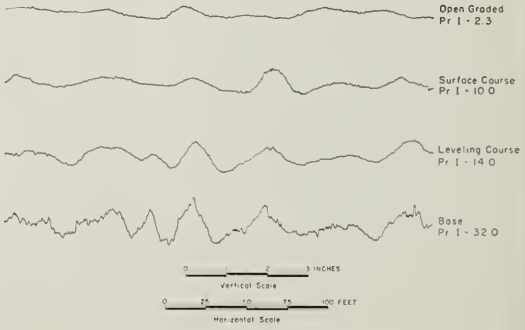


FIGURE 29—A comparative chart showing the improvement in riding qualities (reading bottom to top) as successive layers of pavement are placed over a base.

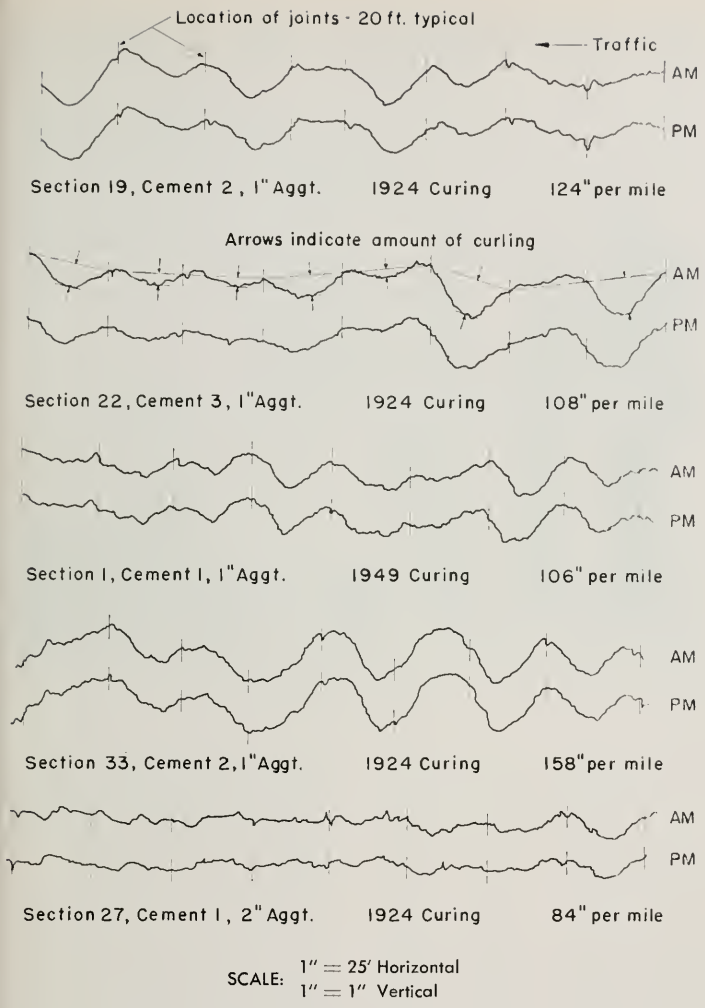


FIGURE 30—A profilagram record of the Topeka road test showing warping or curling of pavement slabs.

disagreement. In the intermediate zone it is not unlikely that there would be some difference of opinion as to which pavements are smoother than others.

Profile Anolysis

Various expedients were tried seeking to convert the profilogram records to a numerical scale that would correlate with the jury classification.

To speed up the evaluation and make use of the fact that rough roads showed short waves or "scallops" having ordinates over three-eighths inch, Mr. Don Spellman conceived the idea of evaluating roads on the basis of vertical deviations only after blanking out those portions of the profile showing only minor inequalities which apparently cause little discomfort to the passengers in a motor vehicle. A "blanking" band of 0.2 inch was arbitrarily selected and a summarization of the measurements of the peaks and low points exceeding that amount were made on several profiles by selecting one-mile sections that were typical of the job.

It was found that a minimum of one mile of profile was needed to obtain a reasonably representative section of road. Even then some profiles exhibit wide differences in appearance from one end to the other and cannot well be represented as "average." This is one distinct advantage of the profilogram record in that such varying areas can readily be seen on the graph and located on the road. The entire profile could be used in an analysis but of course this would lengthen the time required. The counts or total number of inches deviation obtained by this method varied from two inches to over 90 inches per mile. To avoid confusion with previously established usage, the term "inches per mile" in excess of 0.2 inch will be given another name, to indicate that these values are derived from the profile. This term "profile index (0.2 in.)," leaves room for other terms which may correlate better with "riding quality." A profile index (0.2 inch) of 2 inches to 10 inches on a portland cement concrete pavement appears to be typical of new pavements and old ones in good condition. Counts of 40 or over would be considered rough. Other methods yet to be devised may better describe roughness or may better express "riding qualities."

Appendix II

STANDARD SPECIFICATIONS FOR PORTLAND CEMENT CONCRETE PAVEMENT

40-1.10. Final Finishing.—After the preliminary finishing has been completed, the edges of an initial pavement lane shall be rounded with an edging tool having a 0.04-foot radius. Transverse contact joints, expansion joints, and joints adjacent to an existing pavement shall be rounded with an edging tool having a 0.02-foot radius.

When a straightedge 10 feet long is laid on the finished pavement surface, and parallel with the centerline of the highway, the surface shall not vary more than 0.01 foot from the lower edge of the straightedge. Upon completion of the pavement, if any high

... Continued on page 71

'Tempus Fugit' Corner

Twenty-five years ago. The following items appeared in the March and April 1935 issues of *California Highways and Public Works.*

FIRST FREEWAY

The State Legislature designated the Arroyo Seco Parkway as a secondary highway in the state highway system, thus making the project eligible to receive allotments from the city's share of the gasoline tax in the Cities of Los Angeles, South Pasadena, and Pasadena for starting work on surveys, plans, and acquisition of rights-of-way on California's *first freeway.*

CATWALKS FOR CABLE SPINNING

A wire rope was drawn across a mile of water between San Francisco and the concrete center anchorage of the San Francisco-Oakland Bay Bridge midway to Yerba Buena Island. It was then raised to the tops of Towers W-2 and W-3 for the first support of the first of the two catwalks built over the bridge tower tops preparatory to spinning the cable of the first of the twin suspension bridges between San Francisco and Yerba Buena Island.

RETALIATION

On March 26, Grizzly Dome, towering 1,000 feet above the North Fork of the Feather River 35 miles east of Oroville, struck back at the river for ages of cutting deeper and deeper through the canyon, and without warning dropped 75,000 cubic yards of rock into the North Fork along the line of the proposed state highway. Work on the highway had not yet reached the vicinity of the slide. George M. Webb was resident engineer on the job.

SNIP WENT ANOTHER BOTTLENECK

The transformed American River Bridge on 16th Street on the northerly approach to Sacramento was dedicated on March 24. Constructed 20 years previously as a two-lane structure, it was widened to four lanes with five-foot sidewalks on either side.

NEW SIGNS HELP MOTORISTS CHECK SPEEDOMETERS



Participating in the unveiling of the new speedometer check signs on the Bayshore Freeway were (right to left): Assemblyman Charles W. Meyers of San Francisco, Captain John Kennedy, in charge of the San Mateo unit of the California Highway Patrol, and Assistant State Highway Engineer J. P. Sinclair of District IV.

Following the adoption of Assembly Resolution No. 394 in the last session of the Legislature, new signs to assist motorists in checking speedometers have been installed at various locations on state highways.

The complete installation in each test location consists of black-on-white enamel signs showing: Speedometer Check Ahead, Mile 0, Mile 1, etc., and a final signpost with both Ending Mileage and End of Check. Signs are installed along the shoulder areas on both sides of a relatively straight, level section of highway. By noting the speedometer reading at the time of passing the Mile 0 sign and again upon reaching the last Mile sign, motorists will have a check on the accuracy of their speedometers in measuring distance traveled.

The first unit for use in the San Francisco Bay area, a two-mile interval, was installed along the open water portion of the Bayshore Freeway in San Mateo County near the south city limits of San Francisco. In company with Division of Highways representatives in District IV, Assemblyman Charles W. Meyers of San Francisco, author of the resolution providing for use of the signs, participated in the introduction of the signs along this first unit on February 25, 1960.

Two additional locations have been selected for similar installations in the Bay area and signs are now in process of installation: the Nimitz Freeway in Fremont near the Alameda-Santa Clara county line and US 101 between Cotati and Santa Rosa in Sonoma County.

BEAUTIFICATION PROJECT

In Santa Monica on US 101 Alternate along the famous Santa Monica Bluffs, the use of SERA workers furnished the labor for this most difficult of beautification projects, the State furnishing the materials and supervision.

Bridge Costs

Continued Decline Shown In Price Survey for 1959

By H. K. MAUZY, Senior Bridge Engineer and
W. J. YUSAVAGE, Assistant Research Technician

THE YEAR 1959 was the second consecutive year in which bridge construction costs were lower than those of the preceding year. The cost data maintained by the Bridge Department shows that the year 1957 represented the high point of costs with an index value of 283. During 1958 the index dropped to a value of 267, or to a level 5.7 percent below that of 1957. During 1959 the index dropped still further, to a value of 260 or to a level 2.6 percent below that of 1958. Since the budget expenditures by the Bridge Department were roughly $65.1 million and $44.3 million for the years 1958 and 1959, respectively, real savings relative to the cost level of 1957 were roughly $4 million and $3.7 million for the corresponding years. (The 1959 figures do not include those for the Webster Street Tube and the Benicia-Martinez Bridge. The corresponding totals for the two projects were $15,513,365 and $14,238,485.)

This article is the eighth of an annual series dealing with California bridge construction costs. The seventh article appeared in the March-April 1959 issue.

The level of costs for successive periods is presented graphically in an accompanying chart which summarizes the course of California bridge construction costs since 1934.

Construction Activity

Due to the curtailment of funds for the Interstate Highway Program, the value of bridge work let to contract during 1959 was less than that for any year since 1953. The index of value, the measure of construction activity in terms of current dollars, dropped to a value of 860 or to 33 percent less than the 1958 value of 1,287. Coincidentally, the index of volume, the measure of construction activity in terms of 1939-40 dollars, dropped to

INDEX RELATING TO CALIFORNIA BRIDGE CONSTRUCTION AND PERIODIC DOLLAR VALUES OF LOW BIDS ON CALIFORNIA BRIDGE CONSTRUCTION

I Year	II Quarter	III Index of the cost of California bridge construction (1939-1940=100)	IV Index of the value of California bridge construction (1939-1940=100)	V Index of the volume of California bridge construction (1939-1940=100)	VI Index of the bids on California bridge construction (in millions of dollars)
1934		94	*60	*64	3.1
1935		88	*138	*157	7.1
1936		98	*72	*73	3.7
1937		114	*60	*53	3.1
1938		99	*78	*79	4.0
1939		101	*99	*98	5.1
1940		99	*101	*102	5.2
1941		122	*78	*64	4.0
1942		158	*80	*50	4.1
1943		165	*16	*9	.8
1944		153	*29	*19	1.5
1945		167	*109	*65	5.6
1946		182	*247	*133	12.7
1947		215	*443	*202	22.8
1948		229	*307	*134	15.8
1949		201	*233	*117	12.0
1950		202	*269	*129	13.5
1951		248	*617	*247	31.8
1952		235	*561	*237	28.9
1953		229	*522	*227	26.9
1954	1st	221	691	313	8.9
1954	2d	217	1,196	551	15.4
1954	3d	*219 220	*870 1,002	*399 455	44.8 12.9
1954	4th	213	590	277	7.6
1955	1st	217	1,039	477	13.3
1955	2d	237	500	211	6.4
1955	3d	*228 228	*930 1,047	*408 461	47.9 13.4
1955	4th	237	1,148	484	14.7
1956	1st	245	833	340	10.7
1956	2d	284	1,083	381	13.9
1956	3d	*265 260	*1,117 604	*422 232	57.5 7.8
1956	4th	273	1,952	715	25.1
1957	1st	292	680	232	8.8
1957	2d	283	2,007	709	25.8
1957	3d	*283 275	*972 460	*343 167	48.0 5.9
1957	4th	281	740	263	9.5
1958	1st	259	1,219	471	15.1
1958	2d	268	1,841	687	23.7
1958	3d	*267 268	*1,287 1,468	*482 548	65.1 18.9
1958	4th	259	528	204	6.8
1959	1st	244 †260	1,437	589	18.5
1959	2d	309	396	128	5.1
1959	3d	*260 292 †262	*860 163	*331 .56	44.3 2.1
1959	4th	253	1,445	571	18.6

* Average annual index.
† Adjusted index due to insufficient quarterly data.

a value of 331 from the 1958 value of 482. The reduction, in terms of current dollars, amounted to about $20,000,000 less than the amount expended during 1958.

The construction activity indexes are designated as indexes of value and volume in the accompanying charts where the values are given for all periods since 1954.

Bidder Activity

The tendency of construction costs to fall during a period when costs in other sectors of the economy were either stable or were drifting upward is a clear indication of the strength of competition which prevailed during 1959. Competition involving bridge work was especially evident during this period; the average number of bidders for each of 115 projects let to contract during 1959 was 8.8 with 39, or 35 percent of the projects, each drawing 10 or more bidders. Bidding on projects let to contract during January 1960 is on a level with that of 1959, indicating that the competition which was generated in the past year is being carried into 1960.

Average Unit Prices

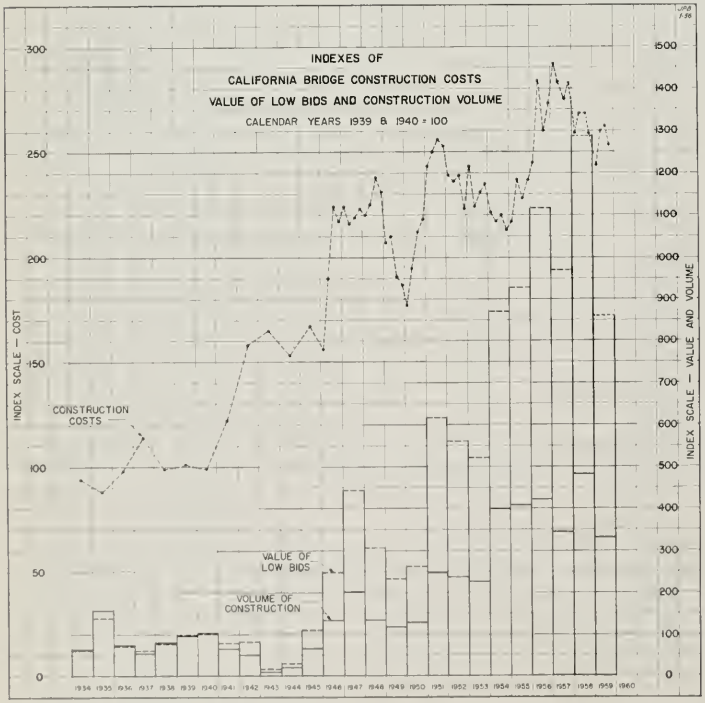
Unit prices for various bridge items declined further from the high levels of 1957. The costs of the three most significant bridge construction items have developed trends which are described as follows:

Class A portland cement concrete (structures) cost an average of $58 per cubic yard in 1957, dropped to $55 per cubic yard in 1958, and during 1959 declined again, to an average price of $52 per cubic yard or to a level 10 percent below that of the average price of 1957.

Structural steel (plate girder) cost an average of $0.205 per pound in 1957, dropped to $0.164 per pound in 1958, and now averages $0.163 per pound, a reduction of 20 percent from 1957 prices.

Bar reinforcing steel which cost an average of $0.123 per pound in 1957 and $0.124 in 1958, dropped to an average of $0.113 per pound in 1959, a reduction of about 9 percent from 1957 prices. In a significant number of projects the price of bar reinforcing steel has been reduced to about $0.10 per pound. The reduction of cost to this level is impressive, especially in view of the fact that a reduction of $0.01 per pound represents a saving of about $1,000,000 in annual construction costs.

An interesting development in connection with the pattern of unit prices is that there seems to be a growing tendency toward less variation among the different sectors of the State. Thus it is not too uncommon today to receive a price quotation of about $55 per cubic yard of Class A portland cement concrete for a project in some remote area such as the Whiskey Creek Bridge, northwest of Redding, where not so long ago such a price would have been entirely unlikely. This tendency to narrow the pattern of cost differentials is apparently due to the increasing industrialization of the state together with much improved accessibility to formerly remote areas.



Summary

Bridge construction costs began to decline during the second quarter of 1957 in conjunction with the then developing period of general recession. The general decline of construction costs continued into 1958 and was continuing at the close of the period of general recession. The persistent depression of construction costs may be ascribed to a significant curtailment in the outlays for the Interstate Highway Program as well as to sizeable reductions in other sectors of heavy construction.

The prospects for increased construction during 1960 are considerable; prominent among such outlays will be those for missile sites, reclamation and flood control projects by the federal government; outlays for industrial construction are likely to be increased, and the outlays for the Interstate Highway Program will also be increased although by smaller amounts than were anticipated several years ago.

The cost of producing steel will be higher but economic writers in gen-

... Continued on page 71

Pack Mules

Age-old Transportation Methods Prove Most Practical on Fence Job

By M. T. TRESIDDER, Resident Engineer

THE construction of freeway fence (Type BW) on State Sign Route 190 (Contract 59-6VC19, Terminus Dam Relocation) is now nearly complete. Due to the steep and rocky terrain in this portion of eastern Tulare County, it has proved to be a very difficult job.

The special provisions required that before any operation involving actual roadway excavation, except construction of pioneer and haul roads, were begun, property fencing on the south side of the right-of-way for the full length of the project was to be constructed; provided, however, that when any one parcel of property had thus been fenced, actual grading operations within the limits of the cross fences could proceed. To comply with this provision and in order to maintain a continuous operation on the fence work it was necessary to construct the fence at various locations in advance of construction of any pioneer and haul road construction.

Use Metal Posts

Components for the construction of the fence consisted of galvanized metal line posts 7 feet in length weighing approximately 22 pounds each and 8-foot tubular steel pipe posts weighing approximately 25 pounds each were required for end and corner posts. In addition to concreting the









The photos above were taken on the job to show some of the operations and the conditions under which they were performed. Supplies and equipment had to be brought up to the work site on mules.

end, corner and pull posts the special provisions required that when rock was encountered the line posts were to be placed in drilled holes and concreted therein. The latter proved to be the rule rather than the exception in many areas. This requirement necessitated the use of pneumatic drills and 500 feet of air hose was required to gain access to the fence line from vantage points where a compressor could be situated.

The major problem that arose during the construction of the fence was the matter of getting the construction materials up to the work area. During the first month of operations materials were taken as close to the work area as possible by means of a four-wheeled-drive vehicle and then were transported manually from that point. Each man was able to carry only two posts at a time and this method proved to be very slow and costly. This work was being undertaken in the middle of summer when the temperature was often in excess of 100 degrees, and to say the least it was a back-breaking job to carry this material to the fence line.

Mules Are Hired

When it became evident that the work areas were getting farther from locations that were accessible to a vehicle a packer with horses and mules was hired to transport the materials to the work areas. This method was very satisfactory and the production of fence construction gained accordingly. For the purpose of carrying posts outriggers were affixed to the pack saddles and the posts were tied to them. Each mule or horse was able to carry eight posts or about 175 pounds. The packer experienced some difficulty with his animals in the first few days while transporting posts but gradually they accepted their work without any outward signs of hostility.

Canvas side packs (kyacks) were attached to the packsaddles and were used to transport all the ingredients for the concrete, including mixing water in five-gallon cans, rolls of barbed wire, and many other minor items that were required for fence construction.

On the average one saddle horse and two packmules were utilized over a period of about three and one-half months.

Isbell Construction Company of Reno, Nevada, is the prime contractor on the project and the fence work is being done under a subcontract to Anchor Fence Div., Anchor Post Products Inc., of Sacramento.

LATHROP RECEIVES 'ENGINEER OF YEAR' AWARD



Scott H. Lathrop, Principal Engineer for Division of Highways, receives the Engineer of the Year Award of the Engineering Council of Sacramento from John Davis, president of Chapman College in Orange County. (Lathrop is a member of the college's Board of Governors.) The presentation, which was made at the annual awards dinner, was for Lathrop's "gift of time and talent in the enrichment of his community as President of the Sacramento Council of Churches" during 1959. Lathrop has been with the Division of Highways since 1931 and is Director of Personnel and Public Information functions.

Road Building Crew Finds Indian Site

Highway construction and archaeology joined hands on the Terminus Reservoir highway rerouting when workers found an extensive Indian dwelling site and burial ground while removing materials from a borrow pit.

Operations were suspended in the area where skeletons and artifacts were found and Jay von Werlhof, College of the Sequoias instructor and archaeologist for the University of California archaeological survey, was summoned to the scene by project workers. He confirmed that the burials were those of Indians and spent two days making a study of the area.

He said that there were some 20 burials, including several of children, in the doubled-up position traditional with Yokuts and Western Mono burials. Artifacts found included a portable stone mortar, pestles, a round game stone a little smaller than a baseball, obsidian chips, a disk of abalone shell drilled through the middle and other items. Von Werlhof said that the burials could be hundreds of years old. Much of the material was salvaged by von Werlhof for the COS collection although several of the burials were disturbed by curiosity seekers between his visits to the site and some material was lost.

Employees of the Isbell Construction Company and M. T. Tressider, resident engineer for the Division of Highways, co-operated with von Werlhof in the preservation of the artifacts which they had located.

CONSTRUCTION VOLUME

During February the department advertised for bids on 57 highway projects with an estimated value of $65,792,100, and awarded 17 contracts with a value of $21,586,800. During the same period 25 contracts with a value of $2,558,700 were completed. On March 1, 202 contracts with a total value of $344,847,700 were under way.

Bridge Engineer J. W. Green Retires

John W. Green, Supervising Bridge Engineer, Division of Highways, retired on March 1 after 30 years of service with the State. A dinner was given in his honor on March 2 at the Roger Young Auditorium in Los Angeles.



JOHN W. GREEN

Green was born near Jefferson City, Tennessee, on July 13, 1892. He moved to Crawfordsville, Oregon, where he received his early education. He completed his engineering training at Oregon State College, receiving his bachelor of science degree in civil engineering in 1916.

After graduation he worked in steam and hydroelectric powerplant design for the Fargo Engineering Company of Jackson, Michigan, design and construction of mine buildings as plant engineer for the New Cornelia Copper Company at Ajo, Arizona, as engineer with the Pennsylvania Railroad in Pittsburgh, highway engineer with the Michigan Highway Department, and with the U.S. Geological Survey in the Rocky Mountain area of Montana.

After returning from service with the Army in World War I, he worked as assistant bridge engineer for the State of Washington. In 1927 he joined the U.S. Bureau of Public Roads as associate highway bridge engineer in their district and regional offices in San Francisco.

He began his career with the Division of Highways in 1930 when he was employed by the State Bridge Department on preliminary studies, investigations and reports on the San Francisco-Oakland Bay Bridge. Material developed in connection with these studies was incorporated in the report of the Hoover-Young San Francisco Bay Bridge Commission.

When work on the Bay Bridge entered the design stage, Green was placed in active charge of the design, preparation of plans, and specifications for all of the substructure and approaches for the bridge. This included the design of the record-depth caissons used in the construction of the piers.

In 1939, following the completion of the Bay Bridge, he was placed in charge of all Bridge Department work in the southern area of the State.

For the past several years, as a representative of Headquarters office of the Bridge Department, Green has worked exclusively on studies and reports requested by the State Legislature in connection with proposed major bridges in Southern California. These include the San Diego-Coronado Crossing and the San Pedro-Terminal Island project which is now in final design stage.

Green is a registered civil and structural engineer in California and a Fellow of the American Society of Civil Engineers. He was married to Meryle Nelson Green, who died in 1959.

Green lives in Glendora. His retirement plans include golf, photography, and extensive travel.

OREGON TRAIL

Continued from page 46 . . .

route both for recreational and commercial purposes is becoming more evident every day, and it is the resolve of Trinity and Siskiyou Counties to expend every effort toward continuing the work on this road until the entire route is constructed to modern standards.



This view of FAS 1089 south of Carrville in Trinity County is typical of the unimproved sections of the road which are being replaced by modern two-lane highway.

CONFERENCE

Continued from page 10 . . .

program as an outstanding example of federal-state co-operation."

Speaking of state-county relationships in road programs in California, Bradford said these "are acknowledged nationally as wonderful. A Chicago magazine featuring county road problems considered it nationally newsworthy last year that a California county had named a new F.A.S. road after an engineer working for the State Division of Highways." (This was Aramayo Way in Tehama County named by the county after Luis Aramayo, Assistant District Engineer of District II.)

During the special group sessions on Thursday afternoon and on Friday, several Division of Highways engineers delivered papers.

Maintenance Engineer Frank E. Baxter gave a paper on "Road Surface Maintenance" in which he pointed out the average motorist is probably more concerned with the condition of the traveled way surface than with any other visible part of the road, and then discussed how the Division of Highways maintains the various surfaces. In this connection, he said that the California State Highway System includes "approximately 1,700 miles of Portland cement concrete pavement, 10,500 miles of bituminous surface, 1,700 miles of oiled gravel, and even, believe it or not, approximately 100 miles of unimproved, primitive, earth roads."

Assistant State Traffic Engineer R. J. Israel spoke of speed zoning in relation to the 1959 law. Because of the new speed limit, he said, it has been necessary to establish 267 new restricted-speed zones extending over 360 miles of highway.

New Signal Patterns

Assistant Traffic Engineer R. W. Matthews discussed some of the new developments in multiphase traffic signal systems, and explained how they can be best used. "For many years," Matthews cited as an example, "we believed there was only one way to phase a signal with a left-turn lane and that is, Phase A for through traffic, Phase B for left-turn traffic, and Phase C for cross-street traffic. This enabled the through motorist on the highway to look at the side street signal with the knowledge that when it went yellow he should be ready to start. . . ."

New developments, Matthews explained, now offer three ways to phase this same left-turn signal. First, because many intersections handle an uneven amount of traffic in different directions at different times of the day, the original left-turn signal was refined to allow through traffic to continue in one direction if no vehicles were waiting to turn left.

This device speeded up traffic flow, but failed in its purpose if even one car entered the low volume left-turn lane. A new refinement now shortens the cycle in either of the left-turn lanes when traffic demand is light.

Aluminum Alloys Developed

Supervising Bridge Engineer W. C. Kiedaisch gave a paper on "Recent Developments in Small Bridge Design." In conclusion, he said, "The future in bridge design appears as promising as the past. Designs with aluminum alloys have been developed on an experimental basis. The use of high stress large-size reinforcing steel bars together with stronger concretes is probable in the immediate future. Concrete waffle and steel battle decks are being studied by the designers and, together with glued timber stringers (treated and fireproofed), have their economical applications.

"Economy is the primary justification for new design developments but it is surprising how often economy and attractive appearance go together. Fancy railings and exotic portals that used to be the fashion with the bridge designers added nothing to the appearance of the structure, but a lot to its cost. Improvements in bridge design, details, and materials will continue to be necessary if structure costs are to be kept down in a time of rising prices."

More than 500 engineers from California and nearby states attended the conference, which was under the sponsorship of the Institute of Transportation and Traffic Engineering, University of California. This annual conference was set up to provide a means whereby California road men might benefit by briefings on new techniques and other developments and by discussion of their current problems.

OLYMPIC TRAFFIC

Continued from page 38 . . .

ideal. The temperature was slightly above freezing and the sky a brilliant blue. Some 54,000 people visited the valley that day, arriving in 10,000 cars and 310 buses. The only problem was that of traffic jams because the cars just could not be admitted into the valley rapidly enough. This was not serious, as the jams were cleared in an hour or two, and everyone who wanted to enter the valley did so with only slight delay.

Although the operation was definitely blessed with good luck, its success was by no means attributable just to luck. Almost every day of the games, traffic equivalent to that of a rush hour cycle in a major city was handled smoothly and efficiently despite very difficult terrain and driving conditions. The many, many hours of meticulous planning paid off in a well-nigh perfect action, and certainly everyone connected with it added considerably to his experience as well.

James Lick Freeway Extension Adopted

The California Highway Commission has adopted a routing for approximately one mile of the Southern Freeway Extension (State Highway Route 253) in San Francisco between the James Lick Memorial Freeway (Bayshore Freeway) near Alemany Boulevard and Evans Avenue.

The adopted route follows a routing which had been adopted by the City and County of San Francisco before Route 253 was added to the State Highway System by the Legislature in 1959. The San Francisco Board of Supervisors, by resolution dated December 10, 1956, adopted the routing as a freeway. The commission announced in February that it was considering the adoption of a freeway routing and the San Francisco Board of Supervisors was asked if it wished the commission to hold a public hearing on the matter before taking further action to adopt a routing.

Division Announces Recent Retirements

Headquarters Office

George A. Karsten, Highway Equipment Operator-Laborer, 33

George W. Sloan, Highway Equipment Operator-Laborer, 28

Clarence T. Todd, Assistant Highway Engineer, 27

District II

Frank V. Day, Highway Leadingman, 31

District III

Joseph C. Havey, Highway Leadingman, 30

Matthew E. Ryan, Assistant Highway Engineer, 32

District IV

William Kane, Assistant Highway Engineer, 30

District V

Russell A. Adams, Highway Equipment Operator-Laborer, 25

Harold J. Wilkinson, Associate Highway Engineer, 31

District VI

Emil Hokanson, Associate Highway Engineer, 22

District VII

William V. Brady, Associate Highway Engineer, 23

Rex C. Farmer, Highway Foreman, 28

William W. Hollis, Highway Leadingman, 22

Leo A. Penney, Highway Leadingman, 33

Ralph E. Schott, Assistant Highway Engineer, 26

District VIII

Gilbert E. Malkson, Senior Highway Engineer, 31

District IX

Dorothy J. Bright, Assistant Highway Engineer, 15

District X

Elbert B. Clary, Drawbridge Operator, 7

John L. Oneto, Highway Leadingman, 28

Donald T. Wade, Laborer, 26

District XI

Raymond L. Potts, Laborer, 25

William T. Rhodes, Associate Highway Engineer, 38

Headquarters Shop

Harold H. Hamlin, Automobile Mechanic, 28

Shop 11

Horace S. Berry, Automobile Mechanic, 31

Transport Minister Visits District VII

Greater London is a teeming metropolis of 10 million Englishmen, 94 percent of whom use public transportation and the remaining 6 percent automobiles.

This constitutes a serious traffic problem, according to Ernest Marples, British Minister of Transport,



Assistant State Highway Engineer E. T. Telford (left) discusses the Los Angeles Metropolitan Freeway System with Ernest Marples, British Minister of Transport.

who visited Los Angeles early this year to study local freeway and traffic conditions.

In an interview with Edward T. Telford, Assistant State Highway Engineer in charge of District VII, and members of his staff, Marples expressed amazement at the great changes that have taken place in population, economic and industrial expansion, and motor vehicle registration in the City of Los Angeles and California.

In comparing London's transportation problems with those of Los Angeles, the Minister stressed the lack of space in his own city and the attendant difficulties of improving existing traffic facilities and constructing new ones.

Telford outlined the state freeway system in greater Los Angeles and explained results achieved and aimed for in the future to cope with increasing traffic and population. He said that present freeway planning was based on predicated needs over a 20-year period, and that planners were developing broad frameworks with an eye to providing "room for maneuvering" for future planners. He declared that the planning program was a dynamic thing geared to progress and expansion.

Minister Marples questioned the utility of a freeway system within London because of crowded conditions, but was urged by Telford not to discount this avenue of development. "We should strive for solutions today, keeping in mind that a perfect transportation system is next to impossible to achieve. We can at least provide liveable solutions," Telford said.

The Minister's party included John Garlick, secretary; H. Gamble, British consul general; and Sam Taylor, general manager, Los Angeles City Traffic Department. Also present at the interview from the District VII staff were District Engineers A. L. Himelhoch and Lyman R. Gillis.

IN MEMORIAM

District II

Joseph Becker, Highway Foreman.

District III

Earl L. Wortell, Assistant Highway Engineer.

District VIII

John L. Gardner, Highway Engineering Technician.

Mary R. Clifford, Intermediate Stenographer-clerk.

STATE GROWTH

Continued from page 2 . . .

plated in this State provides a unique opportunity to revamp much of our urban environment on a substantial scale in the interests of better living and safer, freer movement. The highway program will not only provide indispensable traffic service; it can, in many situations, help mold desirable land use arrangements. It can help to preserve homogeneous areas on the one hand, and on the other, to divide residential sections from industrial sections, or to effect desirable separation of other dissimilar land uses.

"It can also be a powerful stimulus to urban renewal. With proper co-ordination, the highway system and the land use plan can complement each other."

Catherine Bauer Wurster, Department of City and Regional Planning, University of California, told the conference:

"In shaping the future, no professions have a more significant role than the transportation experts and the urban planners, and their new 'togetherness'—exemplified in this conference—is a fine and hopeful sign. They deal with interrelated aspects of the environment: communication and land use. Their responsibilities are also intertwined, and it is more and more recognized that land use decisions determine future communications requirements, while the location and design of a freeway will in turn greatly influence the future development pattern."

City-County Planning

Hugh R. Pomeroy, director of the Westchester County Department of Planning, White Plains, New York, and a former California legislator and Los Angeles planner, gave a summation in which he suggested that intercity and intercounty planning on a regional basis is needed. He said it would provide a basis for comprehensive area plans to which highway plans could most effectively be related.

As a general comment, Pomeroy said:

"One of the beginnings of wisdom in planning is a recognition of our own fallibility as we attempt to forecast the future and to predict future needs. I am convinced that planning adequately means simply planning considerably beyond what, at any given time, we think we may need in the future.

"When it comes to determining how amply a thoroughfare should be provided for or how much land will be needed for public purposes in the future, it is certain that if the answer can be obtained from a slide rule or a calculating machine, it will not be enough.

"Statistical projections are subject to so many variables when they get more than a short distance into the future that they are seriously misleading unless judgment begins to condition them not very far out and then to take over not so far beyond that. It is too easy to build calculated shortsightedness into what we do.

"Except for some isolated freak situation, have we ever provided too much right-of-way for our thoroughfares, acquired too much park land, built too many playgrounds, provided too much automobile parking space? In the face of an almost universal record of inadequacy and shortsightedness, we should somehow have enough sense to realize that if we must err—and err we shall—we should do it on the side of amplitude—in other words, in the direction in which we must inevitably go. Any error in that direction will be only temporary."

Nineteen speakers and panel members took part in the conference. They included State Senator Randolph Collier, chairman of the Senate Committee on Transportation, Assemblyman Lee M. Backstrand, chairman of the Assembly Interim Committee on Transportation and Commerce, and Assemblyman Ernest R. Geddes. Max S. Wehrly, executive director of the Urban Land Institute, Washington, D.C., was one of the out-of-state speakers.

STATE FURNISHES TREES

More than 150,000 pine and eucalyptus seedlings, all grown in state-owned nurseries, will be planted along nine miles of US 40 in San Pablo and Crockett under a landscaping contract awarded by the State Department of Public Works.

NEILSON W. REESE

Neilson W. Reese, retired engineer of the Division of Highways, died March 14 after a short illness.

Reese retired in January 1955 from the position of assistant district engineer of the Division of Highways in Los Angeles, which he had held since October 1947. He was traffic engineer with District VII from March 1940 to October 1947. His service with the State dated from October 1931, when he was employed as senior bridge engineer, design and construction, on the construction of the San Francisco-Oakland Bay Bridge.

Prior to entering state service, Reese in April 1919 was employed as construction engineer with the Oregon State Highway Department; in 1923 he was design and construction engineer bridge consultant with Dr. Gustav Lindenthal; and in 1928 went into consulting practice in design and construction of dams and powerhouses.

Reese was born in Cleveland, Ohio, in 1894. He attended grade school at Lakewood, Ohio, and high school at Cleveland, and was graduated with a B.S.C.E. degree from the University of Illinois in 1920. He came to California from Oregon in 1930.

He was an Army veteran of World War I.

Reese is survived by his wife, Ruth J., and one son, Jack, who is employed by the Standard Oil Company in the San Francisco Bay area.

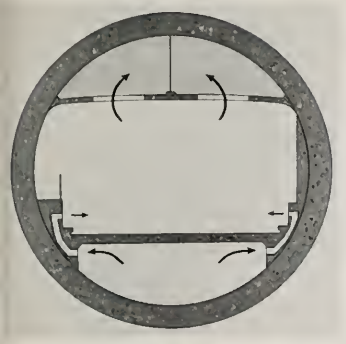
Traffic Slows After Speed Signs Posted

Motorists are reducing their speeds, at least temporarily, following installation of the new 65-mile maximum speed limit signs on highways in open country, a Division of Highways speed check has indicated.

The speed checks were made at locations on US 91-66 north of Victorville, on US 66 southeast of Barstow, and on US 91-466 northeast of Barstow. After the signs were posted, average speeds were from three to five miles an hour slower.

WEBSTER ST. TUBE

Continued from page 12 . . .



Arrows indicate movement of air typical of "Transverse" ventilation system.

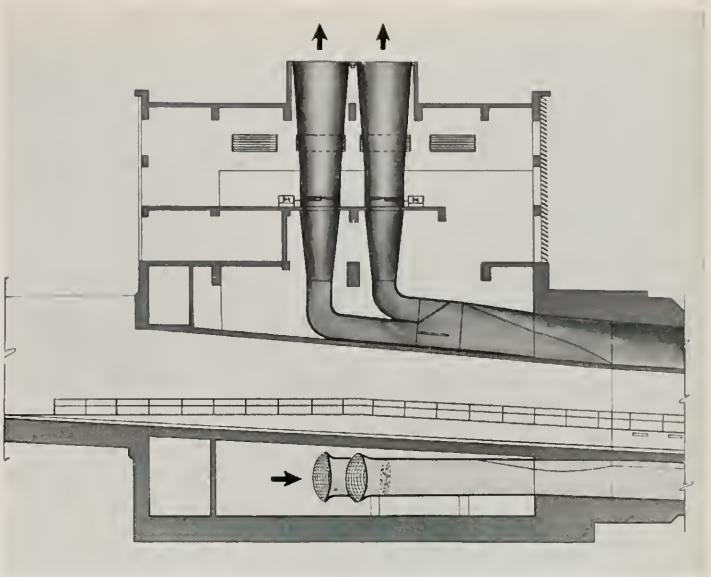
noise level. There is a three-foot walkway on the west side for pedestrians and tube personnel. The tunnel is 3,350 feet long from portal to portal.

The entire area below the roadway slab is used for fresh air supply and the area above the ceiling is used to exhaust air. Air is fed from the supply duct through flues spaced at nine-foot centers along both sides of the roadway and near the roadway level. Air is exhausted through ports in the ceiling spaced at approximately 14-foot centers. This method of ventilation is known as the "transverse" system since there is a minimum longitudinal movement of air in the traveled portion of the tunnel. With this system, smoke and fumes from possible vehicle fires are localized. There are four blower fans and four exhaust fans in each portal building capable of handling nearly a million cubic feet of air each minute.

Has Two Sections

A transverse wall in both the fresh air duct and exhaust air duct divides the tunnel into two sections for ventilating purposes. These walls are placed nearer the Alameda end from the center of the tunnel. This makes it possible to supply more air in the upgrade portion of the tunnel where more vehicle exhaust gases are generated.

The amount of air supplied to the tunnel can be controlled manually or automatically by a vehicle counting device that adds the vehicles entering the tunnel and subtracts those leaving. In this way the amount of air supplied will depend upon the number of vehicles actually in the tunnel. Modern carbon monoxide recorders will keep a continuous record of carbon monoxide content and ensure that reasonable levels are maintained at all times.



Longitudinal cross section of portal building showing arrangement of fresh air intakes and exhaust stacks.

Separate high-voltage electrical services will be installed in each portal building to supply power for all operating needs. There will be a tie cable between the buildings and all power will normally be taken from one source. In case of failure of that source, the load will be automatically transferred to the other source for such length of time as may be necessary.

Protective System Installed

The tunnel has a complete and up-to-date police and fire warning and protective system.

Consideration was given to the communication problem during construction and a private automatic telephone system is included in the contract. This will make it possible to make adjustments in the number and placing of telephone instruments as the needs of the work dictate with the contractor's own forces. As the work nears completion the system will be installed in permanent form for use by the operating and maintenance forces.

Several temporary bridges must be built to permit construction of the tube. A S.P. Co. spur track in Alameda will be carried across the dredged area on a temporary trestle. This trestle will have a removable span to permit the precast segments to be floated past it into position. On the Oakland side, three S.P. Co. tracks at First Street, one W.P.R.R. track at Third Street, a 105-inch interceptor sewer and a 48-inch sewer must be carried across the trench in which the cast-in-place portion of the tunnel will be built. Since this trench varies in depth from about 70 feet to 45 feet, the construction problem can be readily appreciated.

Upon completion of the Webster Street Tube it is planned to close the Posey Tube temporarily and modernize its interior to match the new tube.

When completed both tunnels will be among the most modern in the world.

U.S. 50 FREEWAY

Continued from page 9 . . .



A view showing area cleared for the MacArthur Freeway, looking westerly toward the Bay. Distribution structure at upper left. Present MacArthur Boulevard through Oakland shown at upper right, and again at extreme lower right at the intersection with Harrison Street.

vided. The minimum curve radius on the freeway will be 1,150 feet and the maximum grade will be 4 percent. The freeway will have 10-foot shoulders on the outside with 8-foot shoulders on the inside within a 22-foot median. Shoulders will be provided on structures as well as on graded sections. It is planned to use the new-type cable chain link barrier in the median on the portion now budgeted.

The most complicated and difficult design problems encountered have been where other freeways cross. This occurs at two locations: near the westerly end where the proposed Grove-Shafter Freeway crosses the proposed MacArthur Freeway between Grove Street and Telegraph Avenue and at the easterly end where US 50 intersects Route 228.

The design of the interchange with Grove-Shafter has been completed, and the one with Route 228 has just begun. The interchange with the Grove-Shafter Freeway provides a minimum radius of 600 feet for all freeway movements. It provides for all possible movements between the freeways and also for many local movements from streets in the vicinity. Because this interchange is near the downtown area and in a heavily populated section, there is a large demand for local service at and near the interchange. To properly provide this local service and also a high standard freeway interchange was difficult and costly to accomplish.

Freeway Is Planned

This freeway is planned to be constructed on graded sections, with structures only at grade separations. Retaining walls will be used to save improvements in some areas where economically feasible. It is planned to landscape the freeway to blend in with the surrounding area.

The technical staffs of the cities and counties involved have been very cooperative during the design study stages. The state and local officials all realize that careful planning of freeway connections to local streets is necessary to provide proper traffic service without disruption to freeway or local traffic.

The public is looking forward to the many benefits that will be provided by this freeway. The overloaded Nimitz Freeway along the shore of the bay will be relieved after this freeway is complete. Motorists using Highway 50 will, of course, benefit by timesaving and the increased safety of the new facility. Those who cross the present facility will also benefit. The grade separation features of the new freeway will make it much easier and safer for cross traffic and pedestrians to cross this main arterial. The merchants along existing MacArthur Boulevard will also benefit because of decreased traffic congestion. This will make it much easier for their customers to drive and to park along the existing street. Now that construction is starting, it will not be long until some of these benefits will be realized.

FREEWAYS IN SAN DIEGO

Among recent call for bids by the Division of Highways is a $3,650,000 freeway job on US 80 in El Cajon, San Diego County. This project, along with other current or budgeted jobs, will provide 17 miles of continuous full freeway between Taylor Street in San Diego and Third Street in East El Cajon.

HATCHET MOUNTAIN

Continued from page 34 . . .

As a result of this one failure, a 700-foot section of the embankment had to be removed and stockpiled while the original ground was excavated to a depth of 35 feet for the placing of perforated metal pipe underdrains and pervious material in order to de-water and stabilize the area. The repairs required the handling of 343,500 cubic yards of material, including stockpiling and replacing. By comparison, this amounted to 77 percent of the earthwork required for constructing the entire 3.56 miles of Unit No. 4. Cost of the restoration work was $280,000.

Traffic Used Old Route

A two-mile section of Unit 4 was closed for several months and traffic was carried on the old route during repair work. Experience gained from this development was utilized in the design of the subsequent unit. It is now standard practice to investigate the quality of material underlying all large embankments, to a greater extent than was possible in former years. The district employs mobile drilling equipment capable of penetrating to depths of 150 feet below the surface of the ground. Determination of subsurface water with concurrent unstable soils is of primary importance in the investigation of the embankment foundations.

Unit No. 5 consisted of constructing 5.28 miles of roadway at two locations and terminating at Burney Valley three miles west of the town of Burney. The work was done by M. W. Brown between July 1958 and December 1959 at a cost of $1,421,685. Location "B," between Hatchet Mountain Summit, and Burney Valley, proved to be the wettest area of the entire section. Water was encountered in every cut on the project and each required perforated pipe underdrains. Embankment areas were wet too.

Drains Are Installed

Stabilization trenches similar to the restoration work performed below original ground on Unit 4 were constructed under three embankment areas. A series of vertical drainwells 70 feet deep were installed under an embankment area that would not economically lend itself to the construction of a stabilization trench. The vertical drainwells consisted of 24-inch diameter holes with 8-inch perforated pipe in the center and backfilled with pervious material. The drainwells are designed to act as vertical collector pipes and were placed on 20-foot centers. Two-inch horizontal drains were drilled in to intercept the lower portion of the drainwells and provide an outlet for the system.

All five units have been constructed to a 32-foot roadbed with three inches of bituminous surfacing. Six inches of cement-treated base was used on all but Unit 1 which was 6 inches of untreated base. Imported subbase material or selected material varied in depth from 6 inches to 15 inches as required by the variable basement soil quality.

Units 3, 4, and 5-B are limited access expressway.

Improvement of the section has reduced the distance by one mile, but of greater significence is the 15-minute reduction in average driving time for the 15-mile trip.



West from Burney Valley showing nearly completed expressway.



During canstruction, east side af Hatchet Mauntain, raugh grade completed. Trenches are for perfarated pipe underdrains. Old road appears in left background.

Bridge Department

McMahon Succeeds Panhorst; Downing, Dunn Appointed

Frederick W. Panhorst, the State's Chief Bridge Engineer for the past 29 years, retired April 1 after a long career of public service, most of it with the California Division of Highways.

Panhorst was Assistant State Highway Engineer—Bridges and headed the division's extensive Bridge Department, which handles about $140,000,000 in structure work annually.



F. W. PANHORST

State Highway Engineer J. C. Womack appointed James E. McMahon to succeed Panhorst. McMahon was formerly in charge of the department's branch office in Los Angeles where he served as Bridge Engineer—Southern Area.

Dale F. Downing, Assistant Bridge Engineer—State-owned Toll Bridges, was promoted to replace McMahon as Bridge Engineer—Southern Area.

Promoted to fill the position of Assistant Bridge Engineer—State-owned Toll Bridges was Thomas J. Dunn, Sacramento area construction supervisor.

Saw Staff Grow

During his 33 years with the Division of Highways Panhorst saw the division grow from a staff of 115 to nearly 1,000. During the same period the allocations for bridge construction also grew, starting at $3,250,000 and culminating in today's $140,000,000. Panhorst saw his own responsibilities grow rapidly with the increase in the need for more and better bridges for the State of California.

Before joining the Division of Highways he had worked as an engineer in such areas as naval architecture, plant design and railroad bridge construction. Three years after joining Division of Highways he was promoted to the position of Acting Bridge Engineer, replacing Charles E. Andrew who had been assigned to the San Francisco-Oakland Bay Bridge project. In 1936 Panhorst became permanent Bridge Engineer and in 1947 he attained the civil service rating of Assistant State Highway Engineer—Bridges.

Billion Dollar Total

During his 29 years as department head, Panhorst was responsible for the planning, design, construction and maintenance of what he modestly refers to as "maybe $1 billion" in bridge and tunnel projects, including hundreds of separation and interchange structures for the State's expanding network of freeways. Such complex structures as the parallel Carquinez Bridge on US 40, the Webster Street Tube in Oakland, the Benicia-Martinez Bridge and all of the State's elevated freeway structures were planned and undertaken during Panhorst's tenure as Assistant State Highway Engineer—Bridges.

Work is soon to be started on yet another major bridge project, plans for which were prepared under Panhorst's supervision. This structure, the San Pedro-Terminal Island Bridge at Los Angeles Harbor, will be Southern California's first state toll bridge. Panhorst was also responsible for the operation and maintenance of the San Francisco-Oakland Bay Bridge as well as the other state-owned toll bridges in the San Francisco Bay area.

Praised By Legislature

Born in Mexico, Missouri, Panhorst attended grade and high schools in Staunton, Illinois. He received his bachelor of engineering degree in 1915 and his professional degree in 1936 from the University of Illinois.

Panhorst is a past national director of the American Society of Civil Engineers, and a former president of the Sacramento section of that organization. He is a member of the Structural Engineers Association, the American Concrete Institute, the American Association of State Highway Officials, the American Roadbuilders Association, and the American Toll Bridge and Turnpike Association.

In recognition of his years of faithful and outstanding service to the State of California, House Resolution No. 75 was read and adopted unanimously by the Legislature on March 9, 1960. The resolution cited Panhorst for faithfully and energetically rendering outstanding public service to the people of the State and to all users of California's many highways and bridges.

Started Career in Riverside

James E. McMahon, the new Assistant State Highway Engineer—Bridges, has been with the Division of Highways continuously since 1931, except for five years active duty with the Navy during World War II. At present he is a captain in the reserve.



J. E. McMAHON

He began his career as a member of a highway maintenance crew in the Riverside-San Bernardino region, and later served as a junior highway engineer in the Redding area.

From 1933 to 1936 he worked on the San Francisco-Oakland Bay Bridge project. He returned to Southern California in 1936 as an assistant bridge engineer. In 1953, following a series of promotions, he was advanced to bridge engineer—Southern Area.

McMahon was born in Chebanse, Illinois, and went to high school in Kankakee. He attended Marquette University and received his civil engineering degree from the University of California at Berkeley in 1931. He is a registered civil engineer and a registered structural engineer. A member of the American Society of Civil Engineers, McMahon also is active in the Toastmasters Club.

Joined Division in 1941

Dale F. Downing, the new bridge engineer—Southern Area, has been with the Division of Highways since 1941 when he was assigned to the Bridge Department in Sacramento. Soon after reporting to work he was called to active duty in the Army and it was five years before he was able to settle down to peacetime engineering with the department. Still active in the reserve Downing now holds a commission as lieutenant colonel.



DALE DOWNING

A native Californian, Downing was born in Los Angeles. He attended grade school in Seattle, Washington and high school in Roseville. He studied at Sacramento Junior College and received his engineering degree from the University of California at Berkeley in 1938.

Before his assignment as bridge engineer—Southern Area, Downing was assistant bridge engineer—state-owned toll bridges.

Started as Draftsman

Thomas J. Dunn, newly appointed assistant bridge engineer—state-owned toll bridges, began his career with the Division of Highways in 1931 as a draftsman in the Fresno area. Five years later he became a junior engineer and in 1952, after several years spent as resident engineer on bridge projects, he was assigned duties as an area construction supervisor.



THOMAS J. DUNN

Another native Californian, Dunn was born in Fresno and he attended grammar, high school and Fresno State College all in his hometown. He is a registered civil engineer.

In his new position Dunn will assist Bridge Engineer Howard C. Wood in supervising the operation and maintenance of the five state-owned toll bridges in the San Francisco-Oakland Bay area.

PROFILOGRAPH—2

Continued from page 57 . . .

points are in excess of 0.01 foot, they shall be removed by abrasive means.

In addition to the requirements in the above paragraph, the pavement surface shall be tested by a profilograph in accordance with the methods in use by the Laboratory of the Division of Highways.

The profile index, as measured by the profilograph, for any one-tenth mile section shall not exceed the rate of 7.0 inches per mile along any line parallel to the edge of the pavement. Any deviations, which produce a profile index rate of more than 7.0 inches per mile in any one-tenth mile section, shall be reduced by abrasive means to provide the required profile index. Such abrasive means shall not produce a polished pavement surface. If the daily average of the profile indexes, measured along lines approximately 2.5 feet from the edges of each traffic lane, before grinding, exceeds the rate of 7.0 inches per mile for any three consecutive working days, the paving operations shall be discontinued until suitable equipment and methods are provided by the contractor and approved by the engineer.

Freeway Adopted on Feather River Route

The California Highway Commission has adopted a freeway routing for approximately 7.3 miles of US Highway 40 Alternate (Feather River Highway) between Sloat and 0.7 mile west of the Feather River Inn in Plumas County.

The adopted route generally follows the existing highway but provides some minor relocations to eliminate sharp curves and steep pitches. It was recommended by State Highway Engineer J. C. Womack.

Plans of the Division of Highways call for the construction of a modern two-lane highway, with access control, on the adopted route. Provision will be made for an ultimate four lanes. The estimated cost is approximately $2,275,000 for the initial two lanes, including rights of way for four lanes. Start of the construction will depend on the availability of future highway funds.

Sections Opened on Golden State Route

Two segments of the Golden State Freeway in downtown Los Angeles were opened to traffic March 18.

The two freeway construction projects representing a combined cost of over 10½ million dollars complete the Golden State Freeway from Sixth Street to Pasadena Avenue, a distance of approximately two and one-half miles. At the Pasadena Avenue end of the freeway temporary connections are provided by Avenues 19 and 20, one-way routes southbound and northbound, respectively, between Albion and Lacy Streets, and connecting with heavily traveled Riverside Drive and San Fernando Road. At the Sixth Street end of the freeway temporary connections are provided at Boyle Avenue. At various intermediate points along the freeway route are connections to east-west city streets, including interchange facilities with the San Bernardino Freeway.

The Golden State Freeway is now completed at two separate locations, between Sixth Street and Pasadena Avenue and between Glendale and Burbank Boulevards, together totaling some nine miles and a construction cost of more than 26 million dollars.

BRIDGE COSTS

Continued from page 60 . . .

eral foresee no increase in steel prices until after the 1960 election because of the political overtones which have become associated with an inflationary economic situation. Other industries will probably be urged to follow the course of the steel industry to keep prices constant.

The foregoing observation point to a year of general price stability. The improved situation in the field of heavy construction may, however, moderate the current competitive situation and thus open the way to higher construction prices.

EDMUND G. BROWN
Governor of California



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1912



The old photo shows U.S. Highway 101 in 1912 before it was a state highway. This section is just south of the Ventura-Santa Barbara county line. The point in the distance is Rincon Point.

Financed mainly by private contributions, the wooden viaduct was built by Ventura County about 1910. Before it was built, the only road was along the beach, often impassable because of the surf.

For its day, the viaduct was an ambiticus project. Without mechanized road equipment, the cost of rock and earth fill sufficient to raise the roadbed above the surf would have been prohibitive, whereas lumber was cheap.

Although damaged by wave action many times, the viaduct was continued in use until 1924. With funds provided by the new gasoline tax law enacted the year before, a 20-foot high concrete seawall was constructed to hold a fill and protect a 40-foot roadbed.

In 1949 the right-of-way was widened to accommodate four lanes divided. The outer edge of the fill was protected this time by a riprap seawall of boulders weighing up to 10 tons brought from Riverside County by rail. Fill was carried beneath the railroad on a conveyor belt through a tunnel.

1959



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1960



Work has started on the new highway bridge over the upper end of Carquinez Strait to provide a crossing for the San Francisco Bay Area Interstate Loop. The new bridge will cross just downstream (right) from the railroad bridge in the photo above.

The City of Benicia is in the foreground in the picture, with part of the industrial area of Martinez just across the Strait, and in the distance the Clayton and Ygnacio Valleys where the Cities of Concord, Pleasant Hill, and Walnut Creek are growing together into one great residential city at the foot of Mount Diablo. In the upper left of the photo are more of the industrial developments which are gradually taking up the sites along the waterfront between Martinez and Stockton.

At right is Division of Highways ferry MS CARQUINEZ, which will continue to carry traffic between Martinez and Benicia until the bridge is finished. See bridge progress story on page 35.



California Highways and Public Works

Official Journal of the Division of Highways, Department of Public Works, State of California

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FRONT COVER — The aerial view used as the wrap-around color cover for this issue of the magazine was taken from above the new Ventura Freeway-San Diego Freeway interchange (foreground) looking eastward along the Ventura Freeway in the San Fernando Valley.

—Photo by Robert J. Rose

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Ventura Freeway

Last Two Sections in the San Fernando Valley Opened

By F. E. STURGEON and K. P. MOCK, Resident Engineers

GOVERNOR EDMUND G. BROWN, hundreds of sightseers, officials and the general public were on hand on April 5, 1960, to attend ribbon-cutting ceremonies on the Ventura Freeway, marking the completion of two separate contracts together totaling about 8½ miles of new freeway at a construction cost in excess of $14,000,000. Formal opening of these two links completed the Ventura Freeway in the San Fernando Valley.

> "This fine, modern transportation facility is dedicoted to the safe and efficient movement of people and things — within and through — the great San Fernondo Valley and to the continued growth and development of the social, economic and recreational well being of the people of the Southern California Empire."
>
> —Governor Edmund G. Brown



Governar Edmund G. Brown officiolly opens the new freeway os Robert E. McClure (left), of Santa Monica, and Arthur T. Luddy (right), of Sacramento, members of the Califorria Highway Commission, look on.

Governor Brown officially dedicated the freeway as a cavalcade of ancient and modern automobiles, school bands, gaily decked paraders





BELOW LEFT—The Ventura Freeway-San Diega Freewoy interchonge with the big cut through the Santa Manica Mountains visible in the right background. View is sauth. BELOW RIGHT—Looking west along construction on the Ventura Freeway between Encino Avenue and Kelvin Avenue. The community of Woodland Hills is in the left background.



and pretty girls formed in a parade at the Coldwater Canyon Avenue Bridge in Studio City. Following brief ceremonies at a "ribbon" symbolized by U.S. Army Hercules and Nike missiles, the motorized cavalcade proceeded in a two-mile-long convoy west to Woodland Hills and Chalk Hill, where it paused for a few words from former Governor Goodwin J. Knight and then doubled back on the eastbound leg of the freeway.

A luncheon attended by more than 300 persons at the Sportsmen's Lodge concluded the day-long festivities. Sponsors of the colorful affair were the Valley-Wide Committee on Streets and Highways and affiliate organizations.

East Contract

One of the two projects opened simultaneously on the Ventura Freeway was the contract to the east, between Laurel Canyon Boulevard and the San Diego Freeway. Under contract to Peter Kiewit Sons' Company for $8,898,000, it stretches 4.3 miles and has been under construction since July 1958.

This contract also called for relocation of Mulholland Drive in the Santa Monica Mountains and construction of a new bridge to carry Mulholland Drive across the future San Diego Freeway.

Among the major structures included on the freeway proper are the following: Tujunga Wash Bridge, Whitsett Avenue Undercrossing, Coldwater Canyon Undercrossing, Ethel Avenue Pedestrian Undercrossing, Fulton Avenue Undercrossing, Sunnyslope Avenue Pedestrian Undercrossing, Woodman Avenue Under-



A crew spreads concrete and places center dowels on the East Cantract.



A finishing float with a burlap drag makes a final pass over the pavement on the East Cantract.

crossing, Los Angeles River Bridge at Hazeltine Avenue, Hazeltine Avenue Bridge over Los Angeles River, Tyrone Avenue Pedestrian Undercrossing and Los Angeles River Footbridge, Van Nuys Boulevard Undercrossing, Kester Avenue Undercrossing, Noble Avenue Pedestrian Undercrossing and Sepulveda Boulevard Undercrossing.

Plans on the main contract called for grading, structures and paving eight lanes of concrete on cement treated subgrade. Major contract items included 2,450,000 cubic yards of roadway excavation, 7,950,000 mile-yards of haul, 217,500 tons of imported subbase materials, 164,000 tons of untreated base, 51,500 cubic yards of concrete pavement, 32,480 cubic yards of bridge concrete, 66,060 lineal feet of concrete and steel piling, 1,800,000 pounds of structural steel, 1.02 miles of sanitary sewer pipe, and 2.7 miles of storm drain pipe.

The major portion of the material required for the fills was obtained from the Mulholland material site, approximately 3½ miles south of the job. This material was within the roadway prism of the proposed San Diego Freeway. No shooting was necessary in excavating—all material was ripped, and then dozed to a 60-foot belt loader. Tractor trucks equipped with "hydro-tarders" and 20-cubic-yard bottom-dump semitrailers were used for hauling. The same haul road was used from the Mulholland area to the interchange of the Ventura and San Diego Freeways as was used on a previous Ventura Freeway project.

Hauling and Paving

In order to avoid interference with public traffic, the contractor erected additional haul bridges at all but two crossings at which points the right-of-way was of insufficient width to permit building them adjacent to the freeway bridges. Manually controlled signals, synchronized to signals on nearby Riverside Drive, were installed at these two locations.

One of these two grade crossings was later eliminated after the deck of the Kester Avenue Undercrossing had been poured, cured and protected from overstressing by special con-

struction. The contractor erected a haul bridge over the structure by spanning the bridge with steel H-beams supported over the freeway bridge abutments and over a temporary pier under the center of the span. This arrangement transferred zero load to the freeway bridge and thus permitted the overweight loads to cross.

Pouring of the concrete for the roadway was done in 24-foot widths, using two pavers averaging 1,700 cubic yards per 8-hour working day. An unusual feature of the paving operations was the use of double header forms bolted together in 20-foot lengths and spiked fast to supporting 4" x 10" planks. This was done to provide an unyielding foundation for the heavy 24-foot paving equipment, including an automatic spray curing rig. Outside lanes were poured to a 9-inch truck-load thickness, the inner lanes being of standard 8-inch dimension.



Concrete finishing operations must be made at the junction with the previous day's run.

Mulholland Bridge

Five different types of bridge construction are represented: welded steel girder, concrete box girder, T-beam and box girder, cored slab, and curved soffit box girder. The Mulholland Drive Overcrossing is the curved soffit box girder bridge, and its center span of 235 feet is the longest of this type ever built in the West. At the piers the arched soffit is 16 feet deep and varies to 7 feet at the center. The bridge provides a 56-foot roadway and two sidewalks 5 feet 8 inches wide.



This photo shows a portion of the scored concrete shoulder strip which is described in more detail in the accompanying article.

The actual construction of this bridge presented some extremely difficult engineering problems. The bridging was to be done over a 125-foot-deep gorge in rough terrain. Because of lack of storage space and working area, the contractor elected to fill the breach with excess excavation from the adjoining Mulholland relocation site, which he did to a height of approximately 12 feet from the soffit of the bridge. Utilizing this earthen falsework fill, he was able to move in his equipment and materials, including 120-foot lengths of 2⅞-inch reinforcing steel, and begin construction operations.

The Mulholland Bridge is supported by end abutments and six central piers; it has one center span 235 feet in length and two connecting spans each 168 feet in length. The vertical distance from the deck of the bridge to the traveled way of the future San Diego Freeway, which will pass beneath the central span, is approximately 85 feet. Another feature of the bridge is walkways with 8-foot-high steel picket railings having tops bent inward as a safeguard for pedestrians.

West Contract

The second Ventura Freeway project, also opened on April 5, extends from Encino Avenue to Kelvin Avenue at Chalk Hill, a distance of approximately four miles. Construction of this section, under $5,312,645 contract to Oberg Construction Corporation and Oberg Bros. Construction Company, was begun on August 26, 1958.

Major structures were built on the West Contract as follows: Encino Avenue Pedestrian Overcrossing, White Oak Avenue Undercrossing, Zelzah Avenue Pedestrian Undercrossing, Lindley Avenue Undercrossing, Etiwanda Avenue Pedestrian Undercrossing, Burbank Boulevard Undercrossing, Reseda Boulevard Undercrossing, Yolanda Avenue Pedestrian Undercrossing, Wilbur Avenue Undercrossing, Van Alden Avenue Pedestrian Undercrossing, Tampa Avenue Undercrossing, Shirley Avenue Pedestrian Undercrossing, Corbin Avenue Undercrossing, Oakdale Avenue Pedestrian Undercrossing and Winnetka Avenue Undercrossing.

Work consisted of grading and surfacing for an 8-lane freeway with Portland cement concrete on cement-treated subgrade. City streets were reconstructed where they join on and off ramps and Burbank Boulevard was reconstructed on new alignment to reduce the skew where the freeway crosses overhead.

In addition to the State's construction cost, $40,000 was contributed by the Los Angeles County Flood Control District under agreement by which the State's contractor built another 9′ x 10′ reinforced concrete box culvert adjacent to the existing double 9′ x 10′ reinforced concrete box to augment the drainage capacity of the Caballero Creek Channel for anticipated future increased storm water flow.

Two Operations

An interesting aspect of this contract was that almost all of the roadway excavation quantity of 1,660,000 cubic yards was located at the westerly end of the project in the Chalk Hill cut, the transportation of which required 3,200,000 mile-yards of overhaul. Two separate earthmoving operations were required. Push cats fed a belt loader which loaded bottom-dump trucks for the long haul and up to 20 scrapers for the shorter haul.

The first order of work was construction of reinforced concrete box culverts at three locations, Caballero Creek, Tampa Channel and Corbin Channel, and completion of two frontage roads for residential traffic circulation; one at the east end, from Etiwanda to Yarmouth Avenues, and the other at the west end, from Calvin to Winnetka Avenues, in order to facilitate the fill operation. The entire project with the exception of the Chalk Hill area is in fill over virtually level ground.

Approximately 250,000 tons of imported subbase material was obtained from the Eden Memorial Cemetery located at Sepulveda Boulevard and Rinaldi Street in the northeast corner of the San Fernando Valley. Approximately 140,000 tons of untreated base material was obtained from a quarry and crushing operation near Bell Canyon in the northwest corner of the San Fernando Valley.

Cement-treated subgrade operations were started on November 19, 1959, and concrete pavement started on November 23, 1959. Approximately 50,000 cubic yards of Portland cement concrete pavement was required; approximately 18,115 cubic yards of concrete and 3,317,000 pounds of reinforcing steel was used in constructing the bridges and pedestrian crossings.

Shoulder Strips

The Reseda Boulevard westbound offramp and the Burbank Boulevard eastbound onramp feature an experimental scored concrete shoulder strip on the right edge of the ramp pavement. Adopted by Sacramento Headquarters design section from a type used on highways in the State of New Jersey, the scored strip is 2 feet wide flush with pavement and with raised projections ½ inch in height. It is designed to discourage vehicular use of shoulder areas on ramps by producing a rumbling, washboard effect on contacting tire treads. Use of the scored strip is limited to locations where suitable drainage conditions exist, and



A view of the new Mulholland Drive Bridge spanning the future San Diego Freeway, taken from the old highway (Sepulveda Boulevard).

the conventional 3-foot rolled gutter can be dispensed with.

Budgeted Projects

East of the Hollywood-Ventura Freeway Interchange the Ventura Freeway is budgeted for construction from Buena Vista Street to the Golden State Freeway at the northeast corner of Griffith Park, a distance of 2.2 miles. The California Highway Commission has allocated $4,400,000 for this project, which is expected to be ready for advertising in the summer of this year. A future allocation will fill in the 2.8-mile gap in the Ventura Freeway from Buena Vista Street to the Hollywood Freeway, making a direct, continuous freeway connection from the Hollywood Freeway to the Golden State Freeway.

Major structures on the budgeted portion of the freeway include Victory Boulevard Overcrossing, Forest Lawn Drive Undercrossing, Los Angeles River Bridge, Riverside Drive Undercrossing and the following equestrian undercrossings: Victory Boulevard, Roberta Street, Crystal Springs Drive, Forest Lawn Drive, Mariposa Street and in the vicinity of Buena Vista Street.

One other project is financed on the Ventura Freeway in the 1960-61 construction budget. This project is located in the City of Ventura in Ventura County and is two miles in length, extending from Palm Street to the Southern Pacific Railroad Overhead and including some construction on the Ojai Freeway as far as Prospect Street. The State Highway Commission has made $6,500,000 available for this project, which is scheduled for advertising this summer.

Project Under Way

One major contract has been under way in the City of Ventura since March 14, 1960. This project is 4.6 miles in length, extending from Telephone Road to Palm Street. Contractor is the Griffith Company, whose low bid was $8,290,756. The tentative completion date is set for March 1962.

Freeway plans call for construction of the following major structures: Telephone Road Undercrossing, Main Street Undercrossing, Lemon Over-



Construction on the Ventura Freeway near Laurel Canyon Boulevard. The Los Angeles River is to the right and Cahuenga Pass in the background. The view is southeast.



Looking east along Ventura Freeway between Sepulveda Boulevard (center) and Laurel Canyon Boulevard (background). The completed Ventura Freeway-San Diego Freeway interchange is in the foreground.



An aerial taken abave the Santa Monica Mauntains shawing (in faregraund) the existing hairpin turn an Sepulveda Baulevard and the new Mulholland Driv Bridge abave it. The huge Summit Cut far the San Diega Freeway is in the middlegraund.

head, Seaward Avenue Overcrossing, Vista Del Mar Undercrossing, Sanjon Creek Bridge, Ventura Underpass, Chestnut Street Overhead, California Street Overcrossing and Ash Street Pedestrian Overcrossing.

Right-of-Way

Steps are now being taken to convert the existing Ventura Expressway from Calabasas to the City of Ventura into a full freeway by eliminating grade crossings. Public meetings, design studies and right-of-way acquisition have been in progress for this phase of the conversion.

Right-of-way for the four-lane divided portion of Ventura Boulevard in Ventura County from the Southern Pacific Overhead north of the City of Ventura to Seacliff is presently being acquired. In this seven-mile stretch considerable relocation and reconstruction of the Continental Refining Company facilities must be made. Right-of-way is being acquired as funds become available.

In acquiring the right-of-way for the bypass of the City of Ventura many difficult and involved problems were encountered. In one case it was necessary to purchase a sizable portion of the main plant of a large lumber company. This property covered a large rectangular area fronting on five streets which included a main office, showroom, parking area, railroad facilities, spur track on property and storage yards. The company supplied eight branches throughout Ventura County with various types of milled lumber, doors and casings. It was necessary to rearrange their entire operation, loading docks, spur tracks and, in addition, provide other areas for their use.

In another case the right-of-way passes diagonally through several large lemon groves operated under lease as one unit, with a large packing and processing plant on the premises. Many problems were involved in rearranging irrigation facilities, wind machines, providing drainage and wind breaks, farm roads and other facilities to keep these properties operating in an efficient and profitable manner.

Also, a large area of State Division Beaches and Parks property along the beach frontage in the City of Ventura was taken and it was necessary for us to replace a similar area for the part taken for freeway purposes. Easy access is now possible to this recreational area, and with a large and expansive development program for this area under way by the Division of Beaches and Parks, and the construction of a small boat harbor in the immediate area, this should prove to be one of the finest recreational spots along the entire coast.



A view northward taken above a completed portion of the San Diego Freeway. The interchange with the Ventura Freeway can be seen in the foreground (left). The arterial to the right is Sepulveda Boulevard. Sepulveda Flood Control Dam is at center left.

The route of the Ventura Freeway as adopted from the Hollywood Freeway to the Golden State Freeway at Griffith Park cut through a picturesque residential area known as Toluca Lake which, of course, housed many individuals employed by the entertainment world as well as such organizations as NBC, Columbia Studios and Walt Disney Productions. The acquisition from the Walt Disney Productions involved the moving of many old movie sets from the part the State acquired. This area was formerly used by Walt Disney as a storage ground for old sets.

Also of interest was the acquisition of a part of Griffith Park, which affected a section of the park known as Travel Town. Travel Town consists of a collection of old steam engines and other antiquated means of transportation. This attraction had to be relocated. Another unique acquisition is a bowling alley (this acquisition as of this date is not complete).

Summary

The Ventura Freeway is officially described as beginning at the Golden State Freeway at Griffith Park and terminating at the Santa Barbara county line 75.4 miles distant. 32.4

miles are located within Los Angeles County, 43 miles within Ventura County. Portions of the route are completed, under construction or budgeted for construction with two exceptions. Gaps yet to be financed include 2.8 miles near the east end from Buena Vista Street to the Hollywood Freeway and 7 miles in Ventura County near the west end from the Southern Pacific Railroad Overhead north of the City of Ventura to Seacliff. The total expenditure of state funds to date for development of the Ventura Freeway, including right-of-way acquisition and construction, amounts to more than $83,000,000.

Revision of Manual On Traffic Devices

A general revision of the basic manual which for many years has provided the accepted national standards for highway signs, signals, and pavement markings is now under way it was announced by Federal Highway Administrator Bertram D. Tallamy.

Tallamy, who heads the Bureau of Public Roads, U.S. Department of Commerce, said that the revised Manual on Uniform Traffic Control Devices for Streets and Highways is expected to be completed this summer. The last edition of the manual was published in 1948 and limited changes were made in 1954.

The new revision of the manual is being prepared by the National Joint Committee on Uniform Traffic Control Devices, which also developed the previous editions. The joint committee, formerly composed of representatives of the American Association of State Highway Officials, the Institute of Traffic Engineers, and the National Committee on Uniform Traffic Laws and Ordinances, now also includes representatives of the American Municipal Association and the National Association of County Officials.

The general revision now under way will result in a new, up-to-dare manual covering modern standards for signs, signals, and pavement markings for all classes of roads and streets. Included for the first time will be standards for modern expressways, including the interstate sysrem.

U.S. 101 RELOCATION THROUGH SAN DIEGO SCHEDULED



Studying a madel af the propased US 101-395 freeway interchange in San Diego are (left to right): Roger S. Waalley, member af the California Highway Cammissian, Jacob Dekema, engineer in charge of District XI af the State Divisian af Highways, and Frank G. Farward, chairman of the Highway Committee (Southern Section) of the State Chamber of Cammerce.

Bids were opened in Los Angeles on June 2, 1960, for the construction of the first units of the San Diego Freeway between Park Boulevard and Sixth Avenue, which will include the proposed four-level traffic interchange at the junction of US 101 and US 395. Four bridges in addition to the four-level structure will be included in the contract.

This first section to be advertised is one of a series of contracts which when concluded will afford the motorist a full freeway between Balboa Avenue in San Diego and the existing Montgomery Freeway in National City. The new development will eliminate 30 railroad crossings, 15 traffic signals, and numerous intersections existing along the present route.

An indication of the project's magnitude can best be appreciated by noting several of the many contract items. More than a million cubic yards of earth will be excavated in the grading operations, while the bridges will consume 18,000 cubic yards of concrete laced with four and one-half million pounds of reinforcing steel.

Estimated completion date for the project is mid-1962.

Motels

How Essential Are Accessibility And Visibility to Business Success?

A REPORT OF THE LAND ECONOMIC STUDIES SECTION, RIGHT-OF-WAY DEPARTMENT

Summation by JAMES R. SMITH, Headquarters Right-of-Way Agent

The success of the modern motor hotel—like any business venture—reflects the successful combination of a great number of factors. Not all of these factors will contribute equally to motel success. In any given instance some will be of extreme importance, while others may be of only passing moment; and to a great extent, their order of importance may reflect only the current opinion and appraisal of the particular expert involved.

Almost without exception, however, motel experts collectively have unequivocally cited "location" as *the* most critical of the various motel success elements. With similar unanimity, motel planners have proceeded from this base to a simple, three-phase admonition: If you wish your motel to be a success, locate it (1) directly adjacent to a highway; (2) on a directly accessible site that is (3) clearly visible to passing traffic. And with this sequence, location and its two major elements—direct access and unlimited visibility—are correspondingly established quite firmly in motel locational theory.

Yesterday—a "prefreeway" yesterday—one needed only to tour the nation's highways to confirm that motel developers were—again almost without exception—heeding all three elements to the letter, and with apparent success. Today, however, the picture is not nearly so clear. A tour of California's expanding freeway network, at least, reveals more than enough examples of de luxe motels—seemingly in successful violation of the traditional locational criteria—to prompt the new admonition-producing question:

How important to the success of the modern motel are the locational elements, direct access and unlimited visibility?



BEFORE: Large undeveloped land parcel adjacent to US 40 near Sacramento, California, in 1953. As a result of the construction shown in the left and lower center (to allow for both the merging of two freeways and the separation of local traffic), the direct access and unlimited visibility aspects of this property are to be significantly altered.



AFTER: Deluxe modern motel constructed on the property after completion of the freeway and after the access and visibility restrictions were clearly evident.

Valuable Answer

While there are many people to whom the answer to this question would be of general interest, there are three people to whom the answer would be of extreme importance, the main basis, perhaps, for decisions involving substantial sums of money.



Aerial photograph showing the circuitous route motorists traveling toward Sacramento must follow to reach the motel. Distance from freeway turnoff to motel parking lot is 1 mile.

These three are the motel investor, the motel lending agency, and the highway right-of-way agent.

The basis of current lender and investor interest in the visibility and access facets of motel location is readily apparent. They are concerned with anything which might significantly influence the success of a proposed motel venture.

Modern motels—in the one-hundred-and-up room sizes which are fast becoming the standard—are constructed in many instances at overall costs which approach $12,000 per unit. Thus the total investment upon which an adequate return must subsequently be generated is clearly substantial, and such ventures can therefore little afford to be based upon any untimely or ill-advised planning. What are the ingredients of success; which are most critical and most important; and how they are reflected in a given site—the answers to these questions become the basic factors on which both investor and lender commitments are likely to turn.

Right-of-Way Concern

The right-of-way agent's interest in the problem is also a direct one, and only slightly less apparent than is the connection between motel investors and lenders.

Motels have traditionally been "roadside" businesses, and as a result of the process of improving highways throughout California, all or portions of both existing motels and potential motel sites have frequently been directly affected by right-of-way acquisition. A continuing study of pertinent aspects of the motel business by the right-of-way profession thus became necessary for several significant reasons.

When acquiring a going motel in its entirety, the right-of-way agent—in order to pay a complete and well documented "just compensation"—simply must know all there is to know about both the specific operation under acquisition and the overall field in general. In short, his position must be that of a well-informed buyer, and it follows that timely, accurate knowledge of such fundamentals as the elements of motel success will clearly be a basic part of his motel data fund.

When right-of-way acquisition is affecting only a portion of either an existing motel operation, or a potential motel site, complete knowledge of the various success factors and their relationships becomes even more critically important. In these instances, the effect of the right-of-way taking and the construction of the new access controlled facility upon both the property and the operation remaining, are the issues of prime moment. Clearly, factual knowledge of the motel success factors which are being effected, and the extent to which any impairment of them is likely to be reflected in the overall success of the operation (and hence its market value) would be vitally necessary.

It is true, however, that because highway needs and concepts have changed over the years, right-of-way acquisition currently is not directly affecting *existing* motel properties as frequently as in the past. Moreover, the expectation that right-of-way purchases will involve even fewer such parcels in the future is a reasonable and logical one and may be readily documented. The preponderance of recent freeway right-of-way acquisition is on new alignment, generally through areas where existing "roadside" businesses are not as yet in existence. It follows, then, that fewer existing streets and highways are currently being improved to full freeway standards than was formerly the case, and thus even fewer future acquisitions of all or portions of established "roadside" businesses are likely.

It is therefore apparent to the right-of-way agent that keeping abreast of changing motel locational concepts is not altogether "operations research" on an increasingly recurring right of way problem, insofar as the acquisition of *existing* motels is concerned. With respect to the effects of right-of-way acquisition upon the *potential* motel site, however, the situation is somewhat reversed, and continuing study of locational theory can be expected to reveal much useful information of value in accurately appraising and fairly acquiring these types of sites.

Location and Success: A Case Study Approach

With motels, as with any other business, the earning of a fair return will depend not on one but on many factors, with each factor contributing proportionally to the final total. A grouping of the major elements of motel success, for example, would certainly include such factors as management, location, competition, age,

size, etc.—all necessary ingredients of profitable motel operations.

It is, moreover, evident that in each particular instance, the contribution and individual importance of the various factors will differ. For example, a good manager can, up to a certain point, overcome many of the disadvantages of competition, motel age, etc. Just as clearly, however, all of the success ingredients must be present in relatively harmonious proportions, or the entire motel operation will not have a fair economic chance.

Of all the success factors, the locational element is undoubtedly most critical. It is also probably the most difficult to pin down. A review of the literature—much of which is noted in the "References" at the end of this article—reveals that, over the years, a good motel location has apparently come to mean *proximity to a highway*, *visibility from a highway*, and *access to and from a highway*. Thus premised, an inflexible, "either-or" kind of sequence has developed, and the emphasis on location has tended to move to the extreme—success has meant location *on* a highway, *unlimited* visibility in all directions from a highway, and *direct* access to and from the premises. All of the other success factors have taken a back seat to these locational criteria, and many a motel business failure has been blamed entirely upon inadequacies in the locational "big three" without any attempt to see if nonsuccess might not be more accurately related to some of the other factors as well.

Inexorably, as seems to come to all "black and white" dichotomies, the "shades of gray" examples have recently begun to appear upon the motel scene. Successful instances of motel operations without direct highway access and with only relatively limited highway visibility, can be found here and there throughout the State. Today they are becoming fairly numerous, and they seem still to be on the increase. A sound, case study kind of analysis has thus become available, and a direct, uncomplicated approach can now be taken. One such approach follows:

1. Find an outlying motel in *profitable operation* which has only *limited visibility* and markedly *indirect access* from an adjoining freeway facility.
2. Determine just how important "location's" various subelements have been to that motel's success, by determining where they fit into its particular picture.

A modern, de luxe motel which clearly meets all of the conditions noted in (1) above, has been chosen as the first of a continuing motel case study series. (From time to time other case studies will also be summarized in future issues of *California Highways and Public Works*.)

In the following sections, the location of the motel selected with respect to a major freeway will be described and subsequently related to the entire operation's initial and continued success.

Sacramento Inn

"If you can find it, you'll love it." This is the way a Northern California businessman summed up his impressions of the case study, "Sacramento Inn," after returning home from a convention at that California motel located adjacent to U.S. Highway 40 near Sacramento.

And apparently more than enough patrons are both making the discovery and finding their way back again to keep this motor hotel's owners and manager busy providing suitable accommodations. Although only some 2½ years old, the Sacramento Inn has already expanded twice. Currently, a



Aerial photograph showing circuitous route motorists traveling from Sacramento must follow to reach the motel. Total distance involved in this approach is 1.3 miles.



The Sacramento Inn as it appears to the motorist as he passes directly opposite, the only point where a relatively clear view of the premises is possible. According to traditional motel locational theory, this is too late—the motorist is not likely to turn back, even if it can be assumed he knows where to turn off and how to return. The implied correlation between visibility and motel success is not borne out in the case studied, however.

total of 205 modern units are available for the inn's guests, boosting the total investment in land and buildings into the $2,000,000 class.

The 55-year lease which made possible the entire project started on January 15, 1957. Construction on the initial segment—office, dining facilities, and 100 units—commenced four months later, and was completed in November of the same year. From its opening, the inn has more than fulfilled its owners' expectations. In this respect, the subsequent expansions—which in a sense are empirical evidence of both initial and continued customer acceptance—have already been noted.

This case study is an example, then, of motel success. And actually it is largely for this very reason that the Sacramento Inn is of interest; *it has achieved success in spite of the fact that the site on which it is located violates every one of the success criteria of the "direct access-unlimited visibility" school of motel developers.* As is clearly evident from the aerial and other accompanying photographs, access from adjoining freeway US 40 is neither direct nor short, and visibility is clearly restricted.

Approaching from the southwest—driving from Sacramento—one must leave the freeway at a point 1.3 miles away from the inn itself, measured along the very route which patrons are required to follow. The sequence is as follows: From the long offramp to and along a county road; thence turning into a "Sears Roebuck" parking lot entrance; thence through that parking lot and along the freeway fence to the inn.

Driving *into* Sacramento—approaching from the northeast—the trip from the freeway to the inn is an even one mile. And from both directions, a relatively complete view of the motel from the freeway is first possible only when one is almost directly opposite the inn itself. (This, according to traditional motel planners, is not at all soon enough. The customer has been lost, it is said, as he will never bother to subsequently leave the freeway and find his way back, even if it could be safely assumed he knew how!)

It is well to note that this site was selected and the motel built *after the adjoining freeway had been constructed and opened to travel.* There was in this instance no "before the highway" situation—there was no compulsion or commitment of any kind to choose or utilize the site in the pre-freeway period when such things as visibility and access might have been difficult to visualize. All of the locational advantages and disadvantages were clearly apparent upon the ground and were available for careful study, analysis, and comparison with similar elements for other sites. *The freeway, and any particular locational problems it seemed to present, were known quantities, and had the initial analysis indicated that a million-dollar investment was not advisable, no moneys need have been subsequently committed.*

Investor's Analysis

Why, then, would an informed investor choose such a location, particularly an investor who had other sites available which would have allowed short, direct access and considerably

more visibility from passing traffic? And why has success blessed this investment in such a presumably "paradoxical" spot? Mr. Elwood F. Maleville, the Sacramento Inn's vice president and general manager, sums it up this way:

"There are many factors which contribute to motel success or failure; among them, site access and visibility certainly have their place.

"However, so definitely do such things as recognizing a need for a motel within any general area; determining the overall type and standard of facility which such a need may indicate; and, of course, after establishing just this very kind of motel, seeing to it that a top level of service is subsequently provided.

"In any given situation, just how these and other success factors will be arrayed can only be determined by an individual, on-the-spot survey. Quite often, what holds true for one situation will only rarely hold precisely true for any other.

"I think it is quite clear, however, that the old good-location formula—direct access and unlimited visibility equal motel success—no longer states the case as correctly as it may once have, and certainly all the 'Sacramento Inns' which are being built these days would seem to support this view."

Conclusion

Motels have been traditionally both highway and traffic oriented. This roadside-motorist-service orientation has largely been responsible for certain "success" concepts which have persisted relatively unchanged over the years as the basis of motel locational theory. The basic admonition to locate first and foremost on a site adjacent to a highway is excellently illustrative.

Locational theory has not come down through the years altogether unmodified, however, and outward evidences of certain evolutionary changes have recently become both apparent and numerous. The recent tendency, for example, to locate motels in various parts of the "downtown" section—many times on the more traditional hotel sites—raises some doubt as to the relative importance of "highway" locations to motel success. And the construction of successful "motel rows" along former highway routes which have been "bypassed" by new freeway alignments would seem to suggest that less emphasis upon *new* highway location might also be reasonably premised. (See "Roadside Merchandising," *California Highways and Public Works* magazine, July-August 1957.)

Even during this changing era, however, certain "success" criteria have persisted relatively *unchanged* and *unchallenged*. Among these, that which emphasizes *unlimited visibility* from passing traffic as *the* locational "must" undoubtedly has undergone the least modification; and *direct access* from adjacent traffic lanes has probably run a close second.

Until recently, there seemed little need to question or re-examine these two key concepts. Now, however, the results of changing highway concepts—controlled-access freeways, notably—have been directly responsible for new motel developments which seemingly discount traditional theory. Uncritical acceptance of these key elements—and indeed yesterday's entire location formula itself—may no longer be entirely realistic. A reappraisal of the relative position and importance of *all* motel locational factors seems now to be clearly required, and quite apparently it is the "unorthodox" but successful freeway-oriented entrepreneurs who are forcing a second look at traditional theory.

The motel owner and investor, the highway right-of-way specialist, and the motel lending institution may find, in just these recent developments, significant indications of change in what may well be termed the last of the motel locational theory "holdouts."

The motel noted—The Sacramento Inn—is of particular interest as a case study example in point. Clearly *in this instance, circuitous access and limited visibility have not restricted successful motel operation.*

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Old Roads Recalled, New Ones Praised

Following is an excerpt from a recent letter received by the Editor from Mr. Van Arsdale Smith of 620 Terrace Way, Bakersfield, who obviously qualifies as a veteran California motorist:

"As an 'old timer' who began driving at the ripe old age of 10 years in a 'one lung' Oldsmobile, model 1902, when we had mostly just dirt roads, I have had the good fortune to witness the whole gamut of highway development culminating in the system of magnificently engineered freeways now being built.

"For many years I have received the magazine *California Highways and Public Works* and have marveled at the ingenuity of the Division of Highways in designing these freeways.

"One thing I am sure of, is the fact that freeways are indispensable in California or any other area of mass travel by automobile, truck and bus."

Sierra Highway

Geodimeter Speeds Relocation Survey

By IRA H. ALEXANDER, Chief of the Geodetic Section, Los Angeles County Engineer Department, and A. K. GOLDIN, Chief of Survey



THE ANTELOPE VALLEY, located in the northeasterly region of Los Angeles County and of District VII, is a lightly settled, relatively flat, desert terrain covering an immense area. During the last few years industrial, business and residential development of the area has increased at a very rapid rate due to the aircraft facilities that have been established there.

Increase in population and resultant increases in land values of the area require that plans for design, drainage and right-of-way acquisition for the Antelope Valley Freeway be based upon surveys of a more precise order than were previously available.

The adoption of the Antelope Valley Freeway on a location at some distance from the present Sierra Highway places it in an area not covered by the district's survey Control Systems, and precise horizontal control was urgently needed for that area.

The use of the Model 3 Geodimeter gave the district survey staff a method that was fast, accurate and economical to accomplish this task in the shortest possible period of time. It also will serve as a check in establishing new controls on our older Control Systems on the Sierra Highway.

Control Brought North

Horizontal survey control for the Co-ordinate Control Maps of the district had been brought northerly from the Golden State Freeway along US 6 (Sierra Highway) and into Palmdale, a distance of over 40 miles. The control for this consisted of section line ties and dubious triangulation stations whose values have been questioned, due to earth movements since their establishment. The situation was considered critical and a check on the Control System was required.

The assistance of the Sacramento Headquarters Geodimeter Crew was enlisted and a horizontal control network was established terminating on the Llano Base Line, that had previously been established near the Pearblossom Highway by Los Angeles County.

In 1954 the Los Angeles County Engineer's Geodetic Crews had produced an arc of first order triangulation over the San Gabriel Mountains which included their Llano Base Line.

... Continued on page 69



With the jeep on the left is shown the slave or reflector unit and the walkie-talkie radio used to communicate with the master station. With the jeep on the right is shown the master geodimeter unit, the theodolite, the portable generator for electric current to operate both the master unit and its lights and the radio receiving set for the master unit.

Seismic Tests

Portable Equipment Aids Excavation Study on US 6

By A. D. MAYFIELD, Assistant District Engineer, G. H. LAMB, Materials Engineer and DEWEY KNITTLE, Project Engineer



THE USE of portable, refraction type seismic equipment for selection of excavation methods at sites encountering rock is occurring more frequently in the construction industry. Increasing use of seismic data in the industry has prompted our efforts to secure closer determination of earthwork cost by using a refraction seismograph to investigate subsurface rock formations at large cut sites.

Initial construction on the Antelope Valley Freeway, U.S. Highway 6 relocation, will consist of major grading operations southwest of Palmdale. This portion of the freeway is situated in the rough foothills northerly of the San Gabriel Mountains. Erosion has produced deep incised canyons and numerous exposed beds of sandstone, conglomerate and fractured basalt which have been uplifted by geologic forces.

During the preliminary materials investigation, it was estimated approximately 3,000,000 cubic yards of indurated sandstones, conglomerates and fractured basalts could not be excavated entirely by rippers and scrapers. It was evident that some blasting and shovel work would probably be necessary. A more accurate estimate of the amount of excavation that could be done by scrapers and ripping was needed. Boring with rock bits was considered too costly. A great number of holes would be needed and very expensive pioneer roads would have to be cut in to the drilling sites over relatively inaccessible terrain.

Core Method Inadequate

The geology of the area was well exposed. Because of the difficulty in attaining a direct correlation between the rate of drilling and ability to rip the rock, it was determined drilling and coring would not provide the needed additional information for selection of the most suitable excavation method. A refraction seismograph survey appeared to be capable of obtaining the desired information at materially reduced cost. The seismic type



Morvin McCauley sets off a shot point for a seismic record.



Looking westerly along location of Antelope Valley Freeway with Bee Canyon in foreground and Santa Clara River in background.

survey also would indicate the amount of fracturing within an excavation site. For purposes of correlation, tests were made on the extensive outcrops and compared with results obtained in the refraction tests on the roadway sections.

The refraction seismograph has been used as a basic tool in shallow subsurface investigations for 20 years or more. It has been widely used in geologic studies by the petroleum and mining industries and has been successfully used in several engineering projects, such as dams, highways, tunnels and bridges. Until recently, the refraction seismograph has not been fully used in engineering projects because of complicated and bulky equipment. However, with the recent technological advances in electronics and miniaturization of the past decade, smaller, more compact, and less complicated equipment is available and the portable refraction seismograph is now becoming a standardized tool for use on engineering projects. This equipment operates on the theory that a sharp blow or a dynamite blast at a point of origin called the "shot point" causes sound waves moving outward and downward, the velocity of which can be measured.

Sound Velocity Used

The velocity of a sound wave-front is used in the seismic method to determine depths and differences in degree of consolidation of the underlying material. Wave-front velocities range from 600 feet per second in loosely consolidated soil to 20,000 feet per second in hard crystalline rock. An analogy to sound wave-front travel would be highway travel on a longer detour of smooth roadway at high speed to reach a destination sooner than going more slowly on a muddy direct route in low gear.

As the wave-front progresses outward and downward from the shot point, it is bent along the interface of each higher speed layer surface. This starts wavelets upward toward the surface during the progress of the main front. Beyond a certain distance from the shot point, the wavelet front



Nick Silken and Marvin McCauley review a photographic record from the seismograph like the one shown in Figure 1.

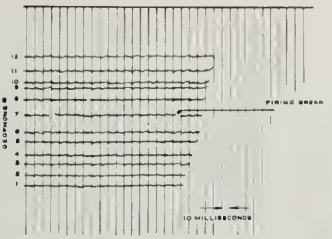


Figure 1. Enlargement of type of seismogram being studied by engineers in photo to the left.



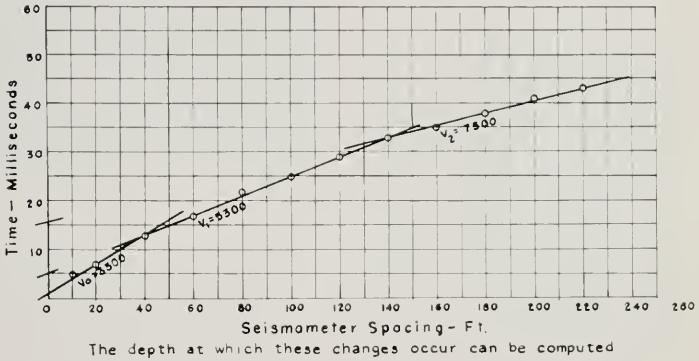
A seismograph recording camera and fire controls with a dark room, developer and fixing bath.

will arrive at the geophones before the arrival of the slower direct wave.

Several portable seismographs are available on the market currently. One such unit was demonstrated at the site by Mr. Horace Church. This equipment consisted of a battery-operated electronic counter, a geophone, an eight-pound sledge hammer, a striking plate and a wire which runs from the sledge hammer to the counter. The electronic counter unit, about the size of a small overnight case, is placed on the ground. Wires are connected to the unit from the sledge hammer and the geophone which is plugged into the ground. The striking plate is placed on the ground, a measured distance from the geophone. The plate is then struck by the hammer and the counter unit is activated by a spring contact switch attached to the hammer. The time from the instant of the blow until the seismic front reaches the geophone is recorded in the electronic counter. The plate is then moved in line with the geophone to another measured distance and the operation is repeated. The distance intervals used are dependent upon the depth and amount of detail required by the observer. This type of instrument is reported to be satisfactory for investigations to a depth of 50'. By the use of blasting as an energy source, the depth of the investigation can be extended.

Portable Unit

The district requested the assistance of the Headquarters Materials and



The depth at which these changes occur can be computed by

V_0 = Velocity of 1st material
V_1 = Velocity of 2nd material
V_2 = Velocity of 3rd material
X_C = Distance intercept
T_1 = 1st of time intercept
T_2 = 2nd time intercept
Z_0 = Thickness of 1st layer
Z_1 = Thickness of 2nd layer

Formula for two layer problem

$$Z_0 = 1/2\sqrt{\frac{V_1 - V_0}{V_1 + V_0}} \cdot X_C$$

Formula for three layer problem

$$Z_1 = 1/2\left(T_2 - \frac{2Z_0\sqrt{V_2^2 - V_0^2}}{V_2\ V_0}\right)\left(\frac{V_2\ V_1}{\sqrt{V_2^2 - V_1^2}}^2\right)$$

Figure 2. A time-distance graph used in seismic recordings.

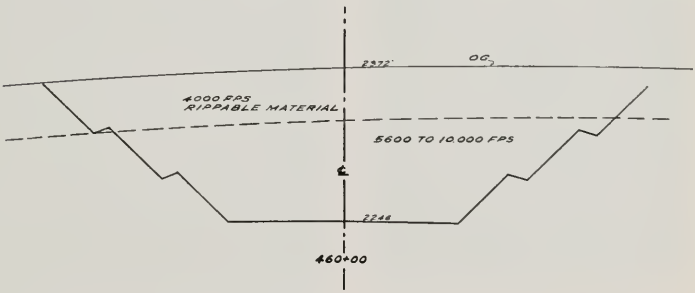


Figure 3. A typicol cross section showing velocity zones.

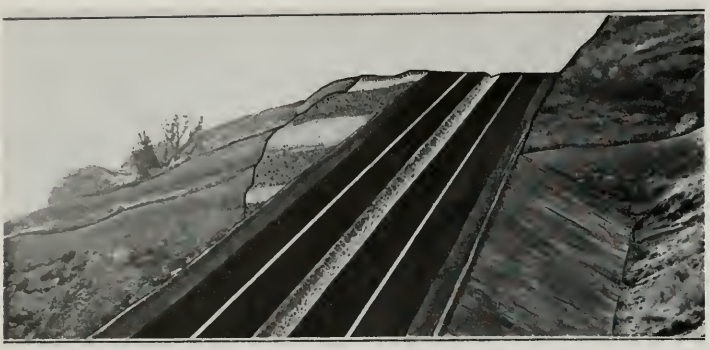


Figure 4. A sketch showing proposed excavation in a sandstone conglomerate bed.

Research Department's refraction seismograph crew. In response to this request, Marvin McCauley and Nick Silken of the Geology Section brought a portable seismograph unit to the site. Although this instrument functions similarly to the one demonstrated by Mr. Church, the operation is considerably different. It consists of a multichannel recorder using 12 geophones. A seismic wave activated at a shot point is picked up by the geophones located at intervals along a predetermined line and carried to a high gain amplifier where the signal is increased several thousand times and fed into sensitive mirror galvanometers in the recording camera. A light beam reflected by each mirror onto rapidly moving sensitive paper imprints signal variations from each geophone. (Please refer to Figure No. 1.) The rate of travel of the paper and the firing instant are synchronized.

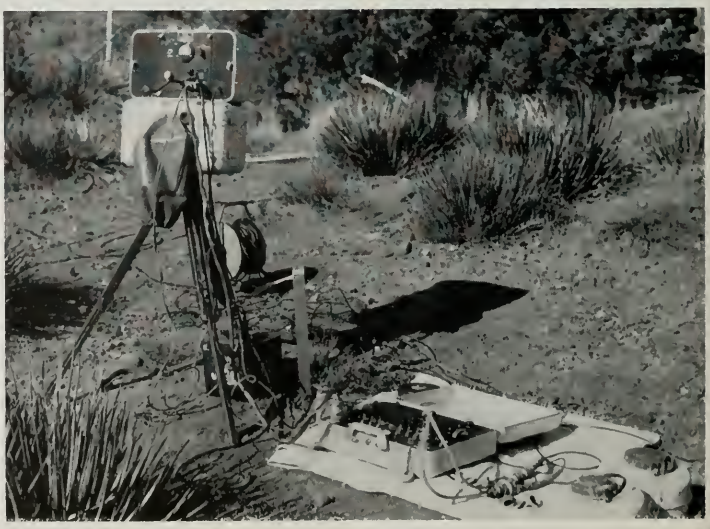
One-third to one pound of 40 percent dynamite is used to create the seismic wave. The spacing of the geophones is varied to provide the accuracy desired. Cross profiles using the geophones were run at right angles to the project centerline as a check on the results determined along the centerline profile. On developing the recording paper, a permanent record is obtained showing the time of the firing break and the time that it took the seismic wave-front to reach each geophone. (This is shown on Figure No. 1.)

Wave Travel Measured

The time for wave-front travel from the shot point to the respective geophones is determined graphically by interpolation from the time lines placed at 10-millisecond intervals on the photographic record sheet. As will be observed on Figure 2, field distances from the shot point to geophone locations and the corresponding time interval produces a time-distance curve. The slopes of the various sections of the time-distance curve are dependent upon the velocity of the shock wave in each type of material and the depth of the contact surface or interface between materials of different type. Intersection points on the time-distance curve are a function of the thickness of each layer and the depth of the contact surface. The velocity in each segment is equal to the incremental distance divided by the incremental time.



Mike Nigro installs a geophone along the shot line.



Refraction seismograph equipment with recording equipment and amplifier.





UPPER and LOWER. Typical terrain an the Antelope Valley Freeway with the centerline of the freeway superimposed.

A general interpretation of the velocity ranges encountered are:

Velocity feet per second	*Excavation method*
Below 4,000	Rippable (conventional earthmoving equipment required)
4,000 to 5,000	Variable. Ripping is questionable
Over 5,000	Blasting will be required

The velocities of the material investigated are considered useful in providing an indication as to whether ripping or blasting methods will be required during excavation of the proposed cuts. Other factors such as joint pattern, stratification, degree of weathering, the amount of fracturing and the tectonic history of the rock can effect rippability. In some instances, water saturation can raise velocity in a low-speed material or lower velocity in a high-speed material in appreciable amount. However, the arid condition of this particular locale precludes much concern for a variance from the general interpretation. In order to provide data for the assistance of prospective bidders in the determination of the type of excavation methods to be employed, it is planned to prepare a series of cross sections through the excavation sites on which will be indicated the different velocity zones for the purpose of calculating the different types of material. A typical example is illustrated in Figure 3.

On the premise that this information is becoming more generally understood by the construction industry, it is believed the providing of velocity zone cross sections will give a more accurate guide to the manner in which the excavation can be accomplished. With this information, interested bidders will have a better guide to subsurface conditions and the State will benefit by receiving lower bid prices.

E. D. Drew, Associate Engineer Geologist and M. McCauley, Junior Engineer Geologist of the Headquarters Materials and Research Department aided in the seismic investigation.

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Free Fill

Embankment Material 'Stockpiled' In Place for Future L. A. Freeways

By RALPH E. DECKER, Senior Highway Engineer, and
FRED W. RADTKE, Highway Engineering Associate



As FREEWAY construction gains headway in the Los Angeles area, the State Division of Highways is stretching the gasoline tax dollar to provide as many more miles of freeway as possible at the least cost to the public. As a part of this "More-Miles-of-Freeways-at-Less-Cost Program," District VII has initiated a procedure whereby it obtains earth for freeway embankments in advance of the actual freeway construction at little or no cost to the State. This is done through making available to responsible persons certain areas within state-owned freeway rights-of-way as disposal sites for their excess excavation material.

The stockpiling of excess embankment material on nearby freeway rights-of-way from a going freeway project has been practiced for many years. There are many instances where this was done on the Santa Ana Freeway, the Golden State Freeway and the Harbor Freeway. In every case, however, the stockpiling was done by a State's contractor and the excavation material came from a state freeway project. It has been only within the last two or three years that the State has enlarged upon this procedure to accept approved embankment material from other governmental agencies and from private contractors.

From the beginning we realized that making arrangements with outside people for placing fill material on state-owned rights-of-way made it



Compacted embankment for San Diego Freeway in City of Torrance placed by State's contractor from excess excavation on Harbor Freeway. This 226,000-cubic-yard fill is in addition to the 1,080,000-cubic-yard 1959 disposal program, as detailed in the accompanying article.

mandatory to organize a standardized procedure, not only for the State's protection but also to assure complete fairness to the people involved.

Potential Sites Determined

Approximately a year ago this activity was made the responsibility of the District Right of Way Clearance Section. The Clearance Section contacts the District Design Department to determine which freeways have potential embankment sites and how much fill material these sites will accommodate. After the right-of-way is acquired by the State, locations which contain large embankment areas normally requiring imported material for construction are given an early priority for clearance of buildings and utilities to prepare these areas for potential disposal sites.

As these sites become available, we are in a position to consider requests from outside parties who have excess earth for disposal. Applicants are advised of the general requirements for use of state lands for disposal sites. Experience has shown that we cannot economically handle small quantities of material and a minimum of 5,000 cubic yards has been established. We have also found it necessary to have the work done under a standard Maintenance Department Encroachment Permit, to which Special Provisions are attached and made a part. Also, a Faithful Performance Bond is required from the permittee. Control of these encroachment permits was delegated to the Right of Way Clearance Section since this section is also responsible for the demolition and clearance of buildings and the relocation of utility facilities which must be accomplished prior to commencement of stockpiling operations.

Conditions Attached

Special Provisions to guarantee the proper placement and compaction of suitable embankment material consistent with freeway construction requirements are attached to and made a part of the Encroachment Permit, and include in general the following: Work Control, Authorized Use of Disposal Site, Work Hours, Storage of Permittee's Equipment and Material, Standards of Construction (consisting of Workmanship, Foundation, Clearing and Grubbing, Concrete Removal, Embankment Material, and Embankment Construction), Disposal of Materials, Expense of Inspection, and Protection of Work. These Special Provisions are similar to and consistent with state requirements for freeway construction projects.



A view of the future Golden State Freeway alignment in the vicinity of the Glendale Freeway Interchange. In the foreground are 14 disposal sites with compacted embankments, a total of approximately 400,000 cubic yards of material. Los Angeles River in background.

The time duration of an Encroachment Permit authorizing construction of embankments on state-owned land will normally vary from 30 to 90 days, depending upon the amount of material the permittee has available for disposal purposes. Generally the time allowed is as follows:

Quantity of material	*Time limit*
5,000 cu. yds.	30 days
10,000 cu. yds.	60 days
20,000 cu. yds. or more	90 days

The permittee is required to furnish the State with a faithful performance bond, known as a P-4 State Highway Permit Bond. The amount of such bond is determined by the State, but usually will be based on the amount of material proposed for embankment as stated in the Permit, as follows:

Quantity of material	*Amount of bond*
5,000 cu. yds.	$5,000
10,000 cu. yds.	10,000
20,000 cu. yds. or more	20,000

A brief summary of the general requirements for embankment construction follows:

In advance of embankment construction, all existing material within the disposal area which is unsuitable for embankment foundation shall be



The proposed alignment of the Santa Monico Freeway between Vermont Avenue and Budlong Street. Approximately 200,000 cubic yards of material has been placed at this location.



Approximately 40,000 cubic yards of material under permit is being placed by a private contractor from excavation obtained from the Pacific Telephone Company building site located at Fourth Street and Grand Avenue, City of Los Angeles. Note dust control by watering of street.

removed from the site to a location outside of adjacent state-owned lands. The site is to be cleared and grubbed. Material which may be acceptable, such as cement pavement, slabs, curbs, gutters, etc., shall be broken up, removed and/or prepared for embankment as directed by the State. The embankment material must have a minimum R-Value of 15, be free of objectionable material, and be approved by the Division of Highways.

Compaction Tests

The permittee is required to protect existing street curbs, gutters and sidewalks which are to remain in place. He is also required to furnish and erect any necessary posts for signs furnished by the State, and furnish and erect any other protection considered necessary by the State to prevent unauthorized dumping. The cost of compaction or material quality tests requested by the permittee shall be paid by the permittee. Except as otherwise provided in the Special Provisions, inspections performed by the State will be done without cost to the permittee.

The State will make disposal sites available on a first-come basis. The disposal site is for the sole use of the permittee, the amount of material placed and its source to be as set out in the Permit. Under no circumstance shall the permittee accept material from other sources for disposal on the site, subcontract for material from other sources, or accept payment from others for permission to dispose of unauthorized material from unknown sources.

The Special Provisions, which have been developed by the District Construction Department, include paragraphs on clearing and grubbing, concrete removal, embankment construction and protection of work. These are sufficient in detail to insure the State that any embankment construction by the permittee will be equal to freeway embankment placed under a major freeway construction contract. The issuance of the Encroachment Permit creates a contractual relationship between the State and the permittee. The permittee is given the exclusive use of a specified site for placing state-approved fill material in what will later be a freeway embank-



Looking north on the future Glendale Freeway with existing Allesandro Street at the right side of photo. District VII has under permit 100,000 cubic yards of freeway embankment in this vicinity.



Disposal sites on the Golden State Freeway in the vicinity of Riverside Drive and Allesandro Street, viewing northerly across Riverside Drive, with City of Glendale in the background.



Easterly view of the future San Diego Freeway in the vicinity of Sepulveda Boulevard and Jefferson Boulevard. Approximately 100,000 cubic yards of material compacted in place with 70,000 cubic yards of lighter colored select material stockpiled on top for future use.

ment, with the District Construction Department furnishing the necessary personnel for the inspection of fill operations. The duration of the encroachment permit normally ranges from 30 to 90 days, depending on the amount of material available for disposal. After satisfactory completion of the work and acceptance by the State, the permittee is notified that his Faithful Performance Bond may be released.

Material Available

Numerous sources of material are available to the State throughout the Los Angeles area. For instance, the Los Angeles County Flood Control District awards many contracts for the excavation of storm drain channels or reservoirs. They advise prospective bidders that they may contact the Division of Highways to determine which areas are available for disposal of earth material from the projects on which they are bidding.

The University of California at Los Angeles has a large building program. When a new project is contemplated, the State is requested to furnish locations of available freeway disposal sites in the vicinity of the project. Also, the United States Army Corps of Engineers confers with the district in advance of advertising contracts involving excess excavation material for disposal.

It is a daily occurrence for private excavating contractors to contact the district office to ask what locations are available for disposal purposes. These private excavating contractors do not always have large amounts of earth to be disposed of; however, in one instance a private excavating contractor placed 70,000 cubic yards.

Why should a public agency or a private contractor place excess material on state's right-of-way without compensation? This can be answered by looking into the economical haul distance to dispose of excess excavation material from some construction sites. The district attempts to find a location to accommodate the excess material within a five-mile radius of the contractor's excavation and, in many instances, has been able to cut down materially the more or less arbitrary haul distance. In such cases the private contractor or the public agency realizes a very considerable saving in the earth-moving operation by utilizing a dumping site on state right-of-way rather than hauling to a public dumping area where a substantial fee is charged for each load received.

Costs Are Reduced

A further benefit resulting from the advanced construction of freeway embankment is a reduction in cost to the State for the maintenance of rights-of-way acquired for future construction. Construction of such embankments virtually eliminates weed abatement expense and reduces unauthorized dumping on rights-of-way to an absolute minimum. Also, in many cases concrete foundations remaining from the removal of buildings can be incorporated in the embankment material and otherwise unsightly areas left in a neat and workmanlike condition resulting in an overall improvement to the appearance of the neighborhood.

To learn how state property may be used for disposal area, the interested party needs only to telephone or write the District VII Right-of-Way Clearance Section, and a brochure, consisting of the general requirements quoted in full above and the special provisions, is mailed.

During the year 1959, District VII accepted 1,080,000 cubic yards of freeway embankment material, compacted in place in conformance with state's construction standards, at a saving to the State conservatively estimated at $1,000,000. The picture for 1960 is even brighter, because as this goes to press we can report another million cubic yards of embankment material received cost free.

The Division of Highways issued 118,622 encroachment permits during the past fiscal year.

Walnut Creek

Freeway Bypass Relieves Traffic On Two Heavily Traveled Routes

By J. F. O'BRIEN, Construction Engineer, District IV



With the cutting of a golden chain by officials of the City of Walnut Creek in Contra Costa County, at ceremonies sponsored by the local area Chamber of Commerce in late March, the freeway section known as the Walnut Creek Bypass was opened to traffic.

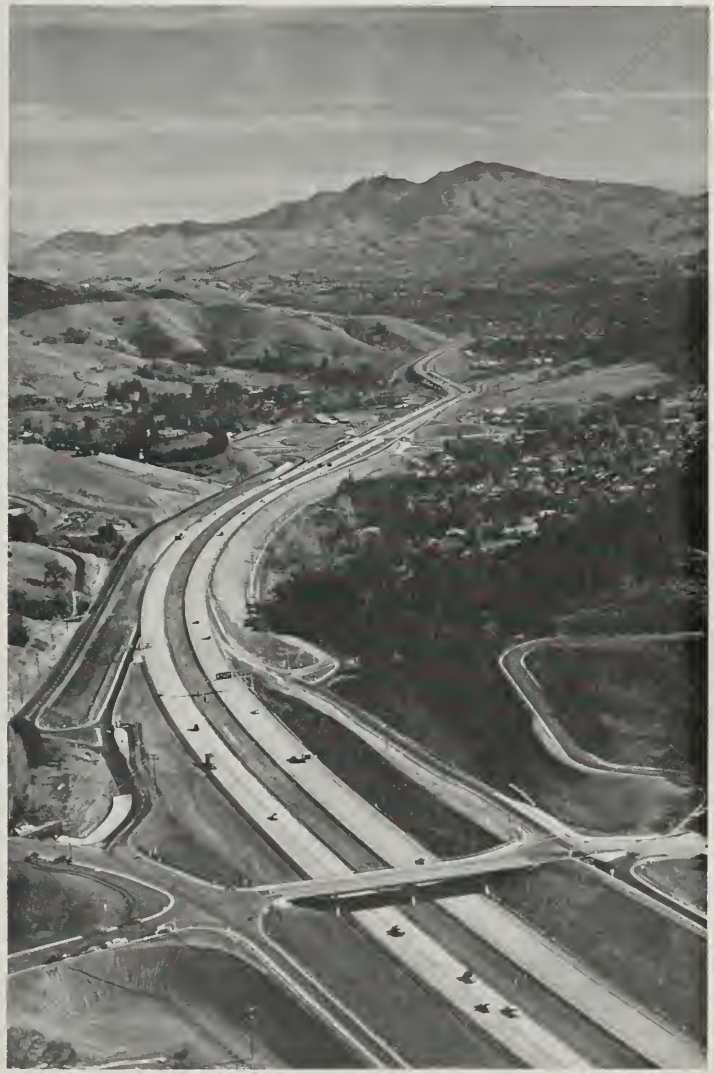
To the region surrounding Walnut Creek, the opening of this freeway section is of great significance.

The city is located at the intersection of Sign Route 21, approaching the city from the south and Sign Route 24, approaching from the east. Both routes are heavily traveled; Route 24, originating in Oakland and proceeding easterly through Walnut Creek and Antioch is of particular importance to the thousands of commuters to the East Bay and San Francisco who use the route daily. Route 21 is becoming increasingly significant as the first easterly connection which bypasses the congested East Bay area for north and southbound Oakland, San Francisco, Martinez and Pittsburg traffic.

Prior to the opening of this freeway section, all traffic on Routes 24 and 21 was funneled through the city street system in Walnut Creek, which was congested beyond capacity.

Another Freeway Link

The completion of this 4.5-mile section adds another link to the freeway system in Contra Costa County, providing a direct connection from the Pleasant Hill Interchange, completed in 1957, to the freeway northerly of Walnut Creek, which extends to Monument Boulevard near Concord. With the earlier completion of the freeway between Orinda and Lafayette in late 1959, a continuous freeway from



View of completed freeway between Orinda and Lafayette. Looking east with Lafayette and Walnut Creek in far background and Charles Hill Overcrossing in foreground.



Looking northerly on Route 107 with South Main Street interchange in foreground and showing interchange separating Sign Routes 24 and 21 in background.

Orinda to Monument Boulevard is now in service.

Approximately one mile east of the Pleasant Hill Interchange, the freeway also branches south to a connection with Sign Route 21 at Crest Avenue near the southerly city limit of Walnut Creek. The main interchange which carries traffic northerly to Monument or southerly to Danville has been aptly described locally as a giant "Y," and also provides direct connection to the existing city street system of Walnut Creek.

This interchange is perhaps the most outstanding feature of the project. With its five major structures and attendant ramps, the three-level interchange provides for smooth flow of traffic between State Sign Routes 24 and 21. Including this main interchange, there were five major interchanges which involved the construction of 16 major structures.

The work consisted of construction of 4- and 6-lane sections of concrete roadway with provisions for an ultimate 6- and 8-lane freeway. Also involved in the work was the construction of frontage roads, city street connections, an extensive drainage system, a concrete-lined channel change, and the installation of a signalized intersection.

In Interstate System

The north-south portions of this project are a part of the federal interstate highway system which will eventually encircle the lower portion of San Francisco Bay and connect with US 80 in Vallejo. Of interest to



View of "Y" interchange in Walnut Creek. Looking northerly on Sign Route 24 to Oakvale Road Overcrossing with North Main Street interchange in background.



Oakvale Road Overcrossing on Sign Route 24, looking south. Slope stabilization through tie-down process, described in article, shows at extreme right.

motorists traveling the newly opened section of freeway are the red, white and blue shields on overhead signs designating Route 680 of the federal interstate system. This is the first installation of such shields in this area.

As is so often the case, in a highly developed area, a large number of utility relocations required close correlation with construction operations. In addition, traffic was carried through the stages of construction operations via a changing series of detours.

Complexity of this $8,500,000 project posed many construction problems.

One of the major difficulties encountered was the unstable cut in the vicinity of the westerly abutment of the Oakvale Road Overcrossing. The slope of the 70-foot cut in the vicinity of the bridge showed evidence of instability during excavation. To insure support for the westerly abutment at the top of the cut and for the spread footings of bents Nos. 4 and 5, special investigation and specialized treatment were undertaken.

Borings made in the area indicated the instability of the cut was due in the main to a circular plane of slippage aggravated by a high moisture content in the soil. The slippage passed below the elevation of the roadway at the toe of the cut and upward into an existing road at the top of cut behind the location of the westerly abutment. Since the slope could not be flattened due to existing streets and improvements, the decision was made to stabilize the slope by restoring the loading which existed prior to excavation. The method used is probably a first in Division of Highways construction. Loading of the slope was applied through three reinforced concrete beams, 15 inches thick and five feet wide, anchored to the abutment at the top of slope and to a tie beam at the toe of slope.

Use Alloy Steel

Beam loading was achieved through high strength alloy steel stress rods of 1⅛″ diameter and was transferred from the rods to the soil through piles cast in 24″ diameter vertically drilled holes. Each pile was 75 feet deep and there were 14 piles per beam. Based on an allowable soil stress of about three tons per square foot, the stressing system consisted of two rods to a pile, each rod being stressed to a load of 50 tons.

This slope stabilization was started during the winter of 1957 and has worked successfully to date.

Slides also occurred on either side of this stabilized section of cut slope. Northerly of the structure one building was removed and the slope flattened to an approximate 3:1 slope. Southerly of the structure a cup-out near the top of slope was packed with coarse rock. On both sides of the structure an extensive system of horizontal drains was installed as a means of further stabilizing the cut area.

Construction of the southern leg of the project on Sign Route 21 required the relocation of a portion of San Ramon Creek. This relocation consisted of construction of a concrete-lined channel 36 feet in width with a height of 14 feet, for a length of approximately 1,000 feet.

Construction began in June 1957 and all work was completed in May of 1960. General contractor on the project was Charles L. Harney, Inc., resident engineer was W. J. Murray, and Bridge Department representative was W. C. Names, all under the general supervision of J. P. Sinclair, Assistant State Highway Engineer.

Coastal Bluffs

Cliff Erosion on US 101 Causes Major Repair Problem

By R. B. LUCKENBACH, Assistant District Engineer, and
VIRGINIA J. SMITH, Administrative Section



THE FORCES of nature, together with certain man-made erosive forces, have intensified and accelerated the deterioration of a cliff which supports U.S. Highway 101 in San Diego County.

Just south of the coastal community of Encinitas US 101 follows a bluff along the Pacific Ocean which has been subjected to weathering and erosion by rain, wave action, and percolation of underground waters, causing the face of the cliff to gradually retreat to the extent that the roadway was endangered. The California Division of Highways therefore began studies to find a method of stabilizing the bluff or relocating the highway.

At its March 1960 meeting the California Highway Commission allocated $490,000 for further erosion control and bluff pratection work along US 101 between Cardiff and Encinitas, to the north of the project described in this article.

Bids for the work were opened in Los Angeles on June 2, 1960.



A view of the slide area on US 101 near Encinitas caused by heavy rains and renewed underground flow. (San Diego Union photo.)

Following a large slipout which occurred in March 1958, plans were completed for installing temporary bulkheading as an emergency measure. At this time a complete study of the entire area was initiated to learn what preventive measures should be undertaken for permanent protection. By this time the cliff had retreated to within one foot of the guardrail. An extended rainy period in April of the same year resulted in a large cave-in, causing the loss of shoulder and guardrail (see photo). Traffic was temporarily routed along the easterly portion of the right-of-way, using the shoulder area for the northbound lanes, while the Maintenance Department constructed the bulkhead retaining wall to restore the full traveled way to use of traffic. Approximately $20,000 was spent on this emergency work.

The problem involved in the overall study was a complex one; there was need for immediate correction, as well as for protective measures to pre-



Emergency bulkheading installed by state highway maintenance forces on US 101 near Encinitas prior to the work described in this article.

serve the highway on a long-term basis. So a dual study was begun. One important factor was the average daily total of 25,000 which must be provided for in an area that affords no additional usable width, as the highway is crowded between the ocean bluff on the west and the railroad tracks on the east. Although the proposed freeway location in this area will be further inland, the present Highway 101 will always be required for increasingly heavy local traffic after the new route has been constructed.

As the weathering of the face of the cliff progressed, a talus deposit developed at the foot along the beach which is just 2.5 feet above the highest tide observed and 20 feet behind the line along which the tide intersects the beach.

In addition to the percolation of rain and natural underground water through soft layers, or aquifers, increasing residential development on the higher land to the east contributed excess free water from leaching systems and irrigation. Since the natural direction of flow was toward the ocean, these waters found a pathway through a soft sandstone layer some 15 to 20 feet below the top of the cliff. Following studies by the district, a plan evolved which would provide stage construction to improve the condition and stabilize the cliff, since relocation of the highway at the time was not economically feasible.

Method Chosen

The area involved is partly within the San Elijo Beach State Park and it appeared desirable to choose a method of correction which would provide a minimum of encroachment on the public beach. And, of course, any solution must provide a maximum of protection with a minimum of expenditure. Various proposals were considered, but most had to be discarded as economically unfeasible, or because of the formidable problem of handling traffic. Some of these alternate proposals are shown in the attached drawings. They range from reinforcement of one-half mile of cliff to reinforcement of two 100-foot areas.

The plan decided upon provided for the first step of a stage-construction stabilization program using a rock fill backed by earth at the base of the cliff. This proposal minimized both the cost factor and the beach encroachment (see drawing). The beach encroachment in this instance is 41 feet.

Another phase of this same proposal was the installation of 800 feet of perforated metal pipe underdrains along the easterly side of the highway to intercept and carry drainage waters across the highway and deposit them where they could no longer endanger the cliff. During the period required to make the study and prepare the job for construction, District XI maintenance forces made weekly checks to chart the progress of the cliff erosion and to stand ready to make any necessary emergency repairs.

Agreement Is Negotiated

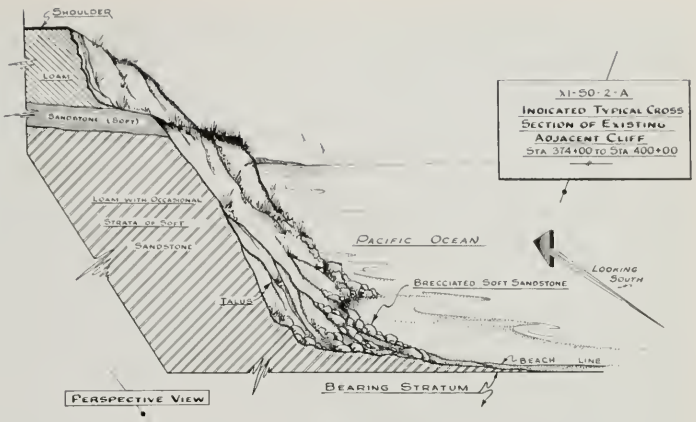
It was also necessary to negotiate an agreement with the Division of Beaches and Parks for permission to obtain needed imported borrow material for the earth fill by excavation

from an area which was planned for future parking space in the state park.

Contractor Ralph B. Slaughter began work on July 30, 1959, to perform the necessary construction to retard the recession of the bluff line. Under this contract and in accordance with the agreement with the Division of Beaches and Parks, the contractor prepared a jeep road over which equipment could travel from the top of the cliff to the beach below. This road will also be used by state park equipment in the future.

During the period of construction two minor slides occurred within the limits of the contract in addition to one larger slide in the area proposed for the next step of the stage construction program.

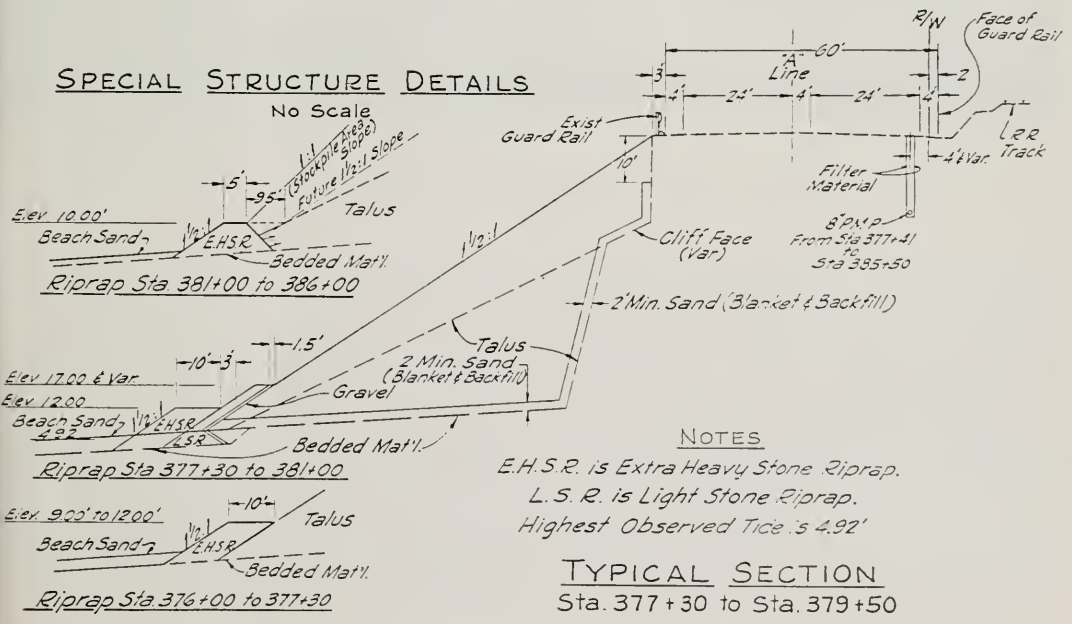
One of the first steps in the project was the removal of the saturated talus material at the base and from the face of the cliff, spreading it out in lifts about one foot deep to facilitate drying and permit its replacement in the completed fill. It was necessary for the contractor to place riprap along the beach to protect this stockpile.



This geologic profile of the slide area shows the location and makeup of the underlying strata.

Under this contract 6,000 tons of heavy riprap and 1,300 tons of lighter riprap were placed at the toe of the slope between Stations 376 and 386, a distance of approximately 1,000 feet. It was necessary for the contractor to time the placing of this riprap to coincide with low tides, since at any other time it was impossible for his equipment to work on the narrow beach shelf. In fact, on two occasions his equipment was caught and stalled by tides.

After removal of the sloping surface from the bluff for its full height, a 1½ to 1 embankment section was



A typical section diagram showing some of the special structure details involved in repairing the slide damage on US 101 near Encinitos.



Looking southeasterly at US 101 showing limits of bank pratection work. Dark area in center shaws full rack riprap section at toe of completed embankment. Light area to north shows partial rack riprap section and stockpiled talus. The next contract which has been advertised will pravide for removal of talus, completian of riprap section and placement of compacted embonkment plus additional work to the north. Right center of photograph shows beach access road and parking orea formed by excavation of necessary borrow materiol.

placed against it. With each lift of the fill a two-foot section was cut out adjacent to the cliff and backfilled with sand to allow water to percolate through this sandy layer rather than through the surface layer of soil which was then put in place.

Seeding Prevents Erosion

After placement of this fill material on the slope, it was necessary to place fertilizer and straw, and then to seed with barley, Italian rye and bermuda to prevent erosion of the surface. Ice plant was not considered suitable due to its heavy surface growth and poor root system.

As previously mentioned, the contract work included the placing of approximately 800 feet of perforated metal pipe on the easterly side of the highway, parallel and adjacent to the highway and the railroad. This pipe, which will intercept subsurface drainage, was placed approximately 19 feet below pavement grade in a bed of gravel filter material. The efficiency of this drainage system is indicated by a daily yield of 28,000 gallons at the outlet.

Vibrations of the earth, caused by passing trains on the track only 20 to 30 feet away presented a hazard to the men working in the trench, and the Santa Fe railroad therefore arranged to have its trains reduce speed while passing through the construction area, thus minimizing the danger.

In addition to timing his operations so that the work at the base of the cliff would be done at low tide, the contractor had to give prime consideration to the handling of traffic on this heavily traveled highway. One-lane traffic in each direction was carried through the job during the initial pipe installation during working hours. However, at night two lanes in each direction were available to traffic.

Other problems which presented themselves during the construction period included continuous water seepage which appeared in different areas, and the two slides previously mentioned.

The contract was completed on November 18, 1959, at a total cost of $114,465.80, exclusive of construction engineering.

Benicia-Martinez

New Methods Used In Substructure Work

By L. C. HOLLISTER, Projects Engineer

The California Legislature in 1955 made possible the construction of two new highway bridges across Carquinez Strait, which had long been a bottleneck for highway transportation.

The Legislature authorized the California Toll Bridge Authority to issue up to $80,000,000 in revenue bonds, redeemable from tolls, to finance the construction of an additional parallel bridge on US 40 near Crockett and another structure between Benicia and Martinez to replace the existing ferry.

The new parallel Carquinez Bridge, costing a total of $46,000,000, is now complete and has been opened to traffic since November 1958. In August 1959 two contracts were awarded which officially started work on the second bridge across Carquinez Strait between Martinez and Benicia.

This new structure will be another important link in the interstate highway system and will provide an outlet to the north for one of the fastest growing areas in California. It will provide a direct connection to the Sacramento Valley and points east and north for cities such as Martinez, Concord, Walnut Creek, Dublin and San Jose.



This 78-inch drill will bore the holes for the steel caissons. An air lift pump will remove the material as it is cut.

The Carquinez Strait at this point is somewhat wider than at the two parallel Carquinez Bridges, and because of this greater width the water is not as deep nor as swift. The total length of the new structure is 6,215 feet and will provide for four lanes of traffic on a concrete deck 62 feet wide between curbs. This width will be sufficient for a 10-foot division strip between opposing lanes of traffic. This area will be marked by painted lines, making



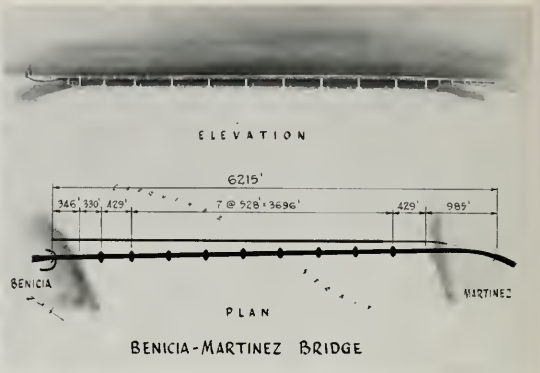
The box footing for Pier 12 has been floated into place and anchored in position. The next operation will be to rig up for drilling the 78-inch holes for the steel caissons.



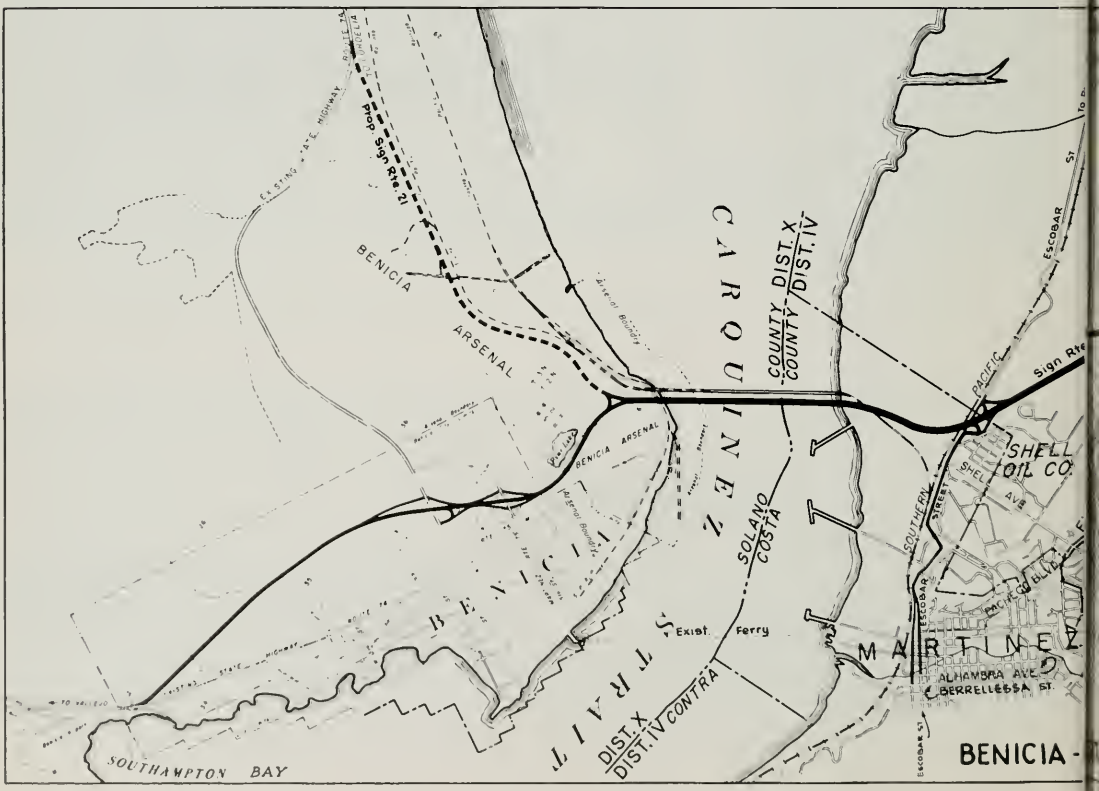
The approach piers under construction. Steel erection on the approach spans began early in May.



An aerial view of the Benicia-Martinez Bridge site. Approach pier construction can be seen at the lower left. The Carquinez Bridge is in the upper right.



A sketch of the Benicia-Martinez Bridge showing the principal dimensions.

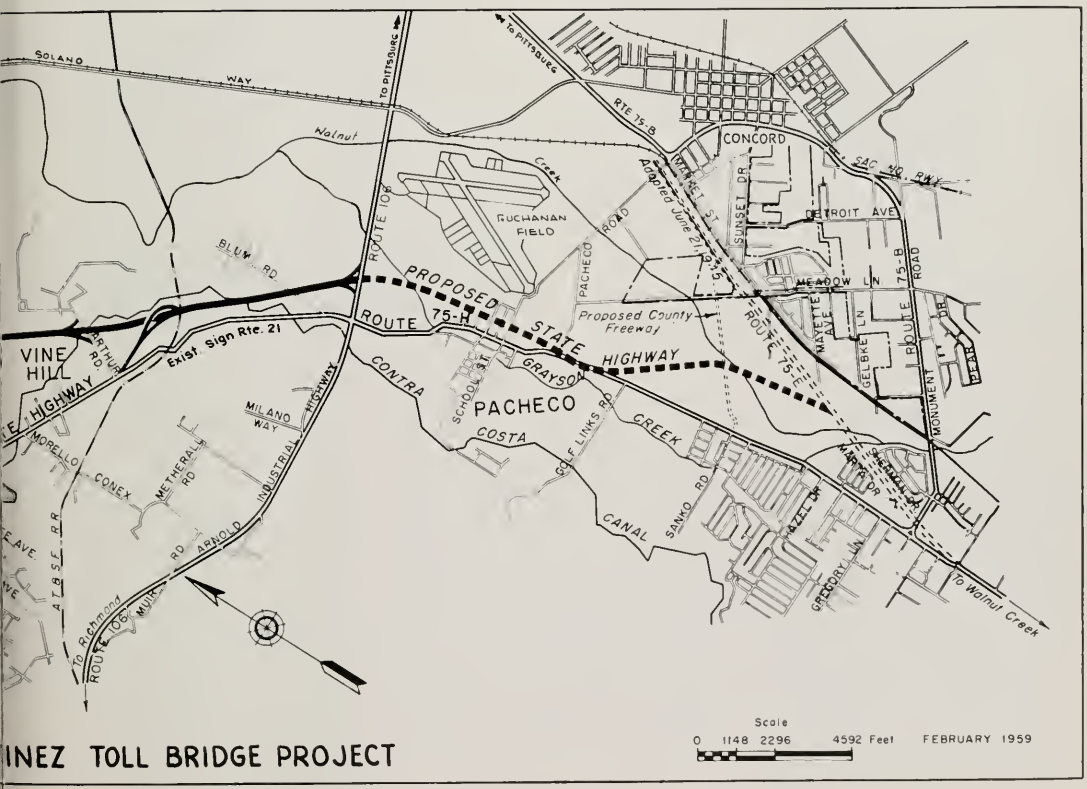




An artist's sketch of the bridge and Benicio interchange as it will appear in the future. The city of Martinez is to the upper right and Mount Diablo upper left.



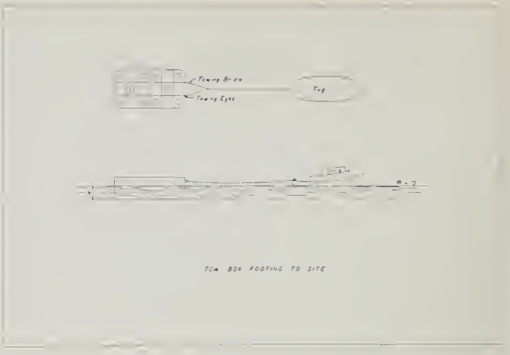
A sketch of the bridge as it will appear when completed. It will be a high-level structure with no openings required for river navigation.



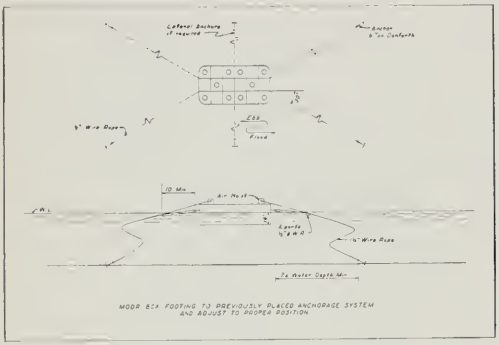
INEZ TOLL BRIDGE PROJECT



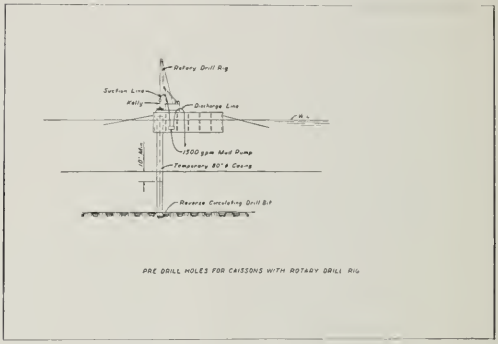
Step 1 consisted of forming and placing concrete bottom slab, walls and partitions for the box footings. After proper curing box footing is slid down the marine ways into the bay.



Step 2 consists of towing box footing approximately 30 miles to the bridge site. Footing weighs about 1,500 tons and has a draft of 14 feet.



Step 3 consists of anchoring the box footing accurately in place. Four anchor lines have so far been used, with attachments available for two additional anchors if required for pier construction in deeper parts of the channel where currents are swifter.



Step 4 consists of setting an 80-inch temporary casing in place. Through this casing a 78-inch drill is positioned and driven by a rotary drill rig at the top. This drill, assisted by an airlift pump which removes the cuttings, bores a hole through the overburden and two feet into bedrock. The 78-inch drill is then replaced by a smaller 62-inch drill, and the hole is bored an additional five feet into bedrock.

the space available for stalled automobiles.

Location Is Downstream

The bridge alignment is not quite parallel to the adjacent Southern Pacific Company railroad bridge and is about 200 feet downstream from it. The location of these two structures is geologically the best location in the area and provides for the shortest length of structure. The new highway bridge, like the railroad bridge, provides for a series of trusses. The highway truss spans are seven at 528 feet, two at 429 feet and one at 330 feet with steel girder approach spans on each end.

Unlike the railroad bridge, however, the highway bridge will be a high-level deck structure providing 138 feet vertical clearance for river navigation and will not have to be opened for the passage of boats.

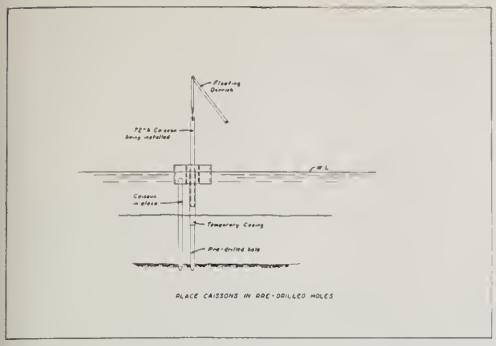
The Yuba Consolidated Industries Inc., through its Judson-Pacific Murphy Division has the contract for both the substructure ($5,769,000) and superstructure ($8,469,465) of this main bridge. Last summer's steel strike has delayed both of these contracts about 3½ months but the work is now going full speed ahead. Contracts are to be let soon for the Contra Costa and Solano County freeway approaches at each end of the structure.

All contracts will be timed for opening the bridge to traffic in the summer of 1962.

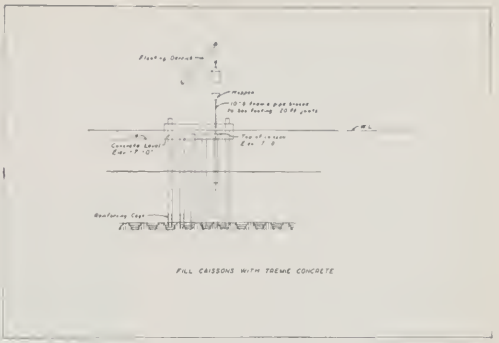
Substructure

Work on the substructure is now progressing rapidly and involves several new and interesting construction features. These features, if proved satisfactory, should have considerable influence on future deepwater pier design and construction for physical situations similar to those encountered at the Martinez-Benicia Bridge.

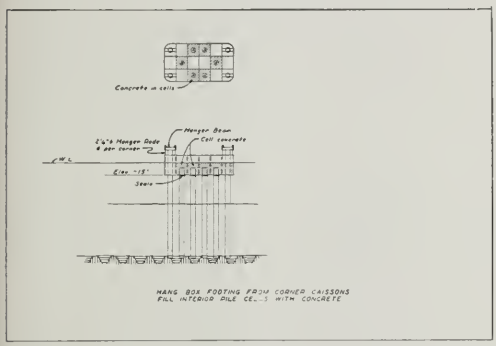
Briefly, the new idea for the foundation design calls for a footing of a type that, if the contractor should elect to do so, the entire footing, which is 86 feet long, 44 feet wide and 25 feet deep, could be built on land and floated into place. The footing as designed is partitioned into 18 cells, making a honeycombed box which can



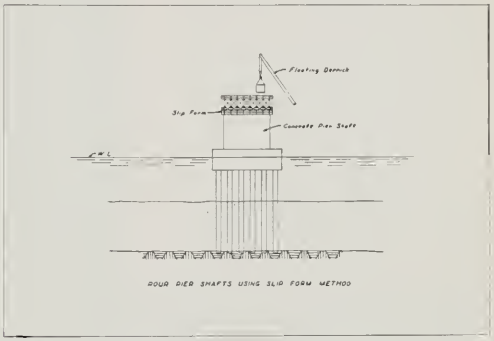
Step 5. The permanent 72-inch steel caisson is placed in the temporary casing down through the predrilled hole and seated on the rock ledge two feet into bedrock. The temporary casing is then removed and made ready for the next drill hole. The permanent steel caissan shell is made from one-inch high-strength steel plates fabricated by welding.



Step 6. Bottom of hole is thoroughly cleaned and inspected by divers to insure that the caisson will rest on and be anchored into good sound rock. A cage of heavy reinforcing steel is then lowered to the bottom of the rock hole and the caissan is then concreted in up to the box footing.



Step 7. The load of the floating box footing is now ready to be transferred to the caissons. This is done by placing heavy steel beams with hanger rods across the four corner caissons at high tide. As the tide goes out the load of the concrete box footing comes to rest on these four caissons. The remaining caissons are then anchored to the box footing. With the load transferred to the caissons the footing and pier are ready for completion.



Step 8 consists of completing the box footing with a 12-inch concrete slab over the top and starting the concrete shaft which will be constructed by the slip form method. Concrete shafts will extend above the footing to a maximum of about 130 feet to form the supports for the steel truss shoes.

be floated. Ten of the cells have 84-inch steel pipes extending from the bottom to well above the water line.

After the footing has been securely anchored in position, 6-foot-diameter steel caissons are lowered through each of the 10 84-inch steel pipe sleeves and sunk to bedrock, which is 120 to 130 feet below mean sea level. This idea is similar to that used by oil companies in the construction of their huge offshore oil drilling platforms.

Sinking the 10 six-foot-diameter steel caissons to bedrock is accomplished in the following manner:

First a temporary casing 80 inches in diameter is lowered into the water and overburden to a point where the mud, sand and gravel overburden is sufficiently stiff to stand on a vertical plane when excavated.

Material Is Pumped

The next step is to lower a 78-inch rotary drill and airlift pump into the temporary casing and drill and pump out the material down to bedrock and two feet into it. At this point the 78-inch drill is removed and replaced by a 62-inch drill which will drill at least five additional feet into bedrock.

If inspection reveals the rock to be sufficiently sound the drill is removed and the 72-inch steel caisson shell is lowered into place at the bottom of the 78-inch hole. The drilled hole five feet below the caisson is then cleaned and inspected by deep sea divers to make sure that the rock footing is of sound material and that the area is clean for receiving concrete. The next step involves placing a reinforcing steel cage in the bottom and concreting the caisson up to the footing block.

The four corner caissons are the first to be placed and concreted in. During this operation, the 86 by 44-foot box footing is still floating. The next step therefore involves transferring the load of the box footing to the four corner caissons. This is done at high tide, and as the tide goes out the footing comes to rest on and is securely anchored to the four corner caissons. When finished the footing

. . . Continued on page 57

Cholame Lateral

Thirty Miles of US 466 Modernized in Six Years

By J. M. STURGEON, Construction Engineer



THE SECTION of U.S. Route 466 that runs between the City of Paso Robles in San Luis Obispo County and US 99 near Famoso was planned in the earliest days of California's highway program as an eventual main east-west connection between the southern end of the Great Central Valley and the Central Coastal area of California.

Geography, population development, and the obvious demands of commerce all pointed to the potential of this "Cholame Lateral" for development into a major artery for both commercial and pleasure traffic.

For many years, however, low-standard alignment through the hills of the Diablo Range, coupled with hazardously narrow roadway widths, kept this potential from becoming an actuality. In the late 1940's and early 1950's, traffic surveys indicated that increasing commercial traffic, together with significant increases in the number of private vehicles using the road not only warranted the improvement of the portion of the highway lying within San Luis Obispo County, but made such improvement imperative.

Work Begins

Starting in 1953, the first section of what eventually was to result in complete reconstruction, on almost entirely new alignment, of the better than 30 miles of this Cholame Lateral lying east of Paso Robles within San Luis Obispo County, was placed under contract. This first contract called for the construction of some 7.3 miles of new two-lane highway between Huer Huero Creek, two miles east of Paso Robles and a point about one mile west of the Estrella River. The next year another contract was let to cover construction, again



An aerial showing the improvement of the ascent to Polanio Pass with the previous highway on the right. View is eastward toward the Kern county line.

on new alignment, of almost three miles between the end of the first contract, across the Estrella River, to a point some two miles east of the river. This same year, a 2½-mile length through the small community of Cholame was built to eliminate some particularly dangerous curves. This stretch ran between Palo Prieto Road and the point where State Sign Route 41 (Route 125) turns off to cross the hills to Fresno via Cottonwood Pass. In this two-year period, then, some 12½ miles of new two-lane highway, built to modern standards, were made available to the users of this road.

In 1956, a contract was let to construct a full freeway on US 101 through the City of Paso Robles. This contract also provided for a new connection at Paso Robles between U.S. Routes 101 and 466, and for the construction on new alignment of two miles of 466 to meet the start of the 1953-54 contract at Huer Huero Creek, providing a total of 14½ miles of continuous, modern two-lane highway from Paso Robles eastward.

In mid-1958 the sudden availability of the so-called "antirecession" federal aid funds made it possible to complete the remaining 17 miles, in effect, all at once, by means of three concurrent contracts.

First Contract Awarded

The first of these contracts to be let was awarded to the Madonna Construction Company of San Luis Obispo on August 28, 1958. It provided for the construction on new alignment of some 8.7 miles between two miles east of the Estrella River and a point some two miles northeast of the town of Shandon. Completion of this $1,022,594 contract was scheduled for early November of 1959.

On October 3, 1958, a second contract was awarded to the Madonna Construction Company for some $717,087 worth of construction on some six miles of new alignment between Route 125 east of Cholame and the Kern county line. Completion was scheduled in August 1959.

The third contract let, and the first of the three completed, was awarded to the Phoenix Construction Company of Bakersfield on October 8, 1958. This last contract called for reconstruction, mostly on existing alignment, of slightly over 2½ miles between Lucy Brown Road and Palo Prieto Road (the start of the 1953-54 "Through Cholame" project). The contract was for $259,188.

On May 22, 1959, the Director of Public Works accepted this latter project as complete. On October 1, the second contract awarded (between Sign Route 41 and the Kern county line) was accepted, and the final 8.7 miles of the first contract, the "Shandon Bypass," was accepted on November 6, 1959.

During construction the two contractors on the three projects, together with their suppliers and materials men, excavated approximately 2,034,000 tons of earth (1,453,000 cubic yards), and dug, screened, crushed or otherwise processed some 370,000 tons of graded aggregates for the bases and the asphaltic mixes used. A mining operation involving the production in a little over one year, of almost two and one-half million tons of material from the earth was just one factor of the many concerned in completion of these contracts.

Projects Are Unusual

These figures become rather startling when it is emphasized that these



Improved alignment of US 466 showing the former highway passing through the town of Shandon (upper left).

Seattle Public Library
JUL 1 1960



The intersection of Sign Route 41 and US 466 looking east to Polonio Pass and the Temblor Range.



An aerial of the reconstructed highway looking west from Cholame.

contracts were for construction of stretches of two-lane highway, and that none of these contracts could be considered out of the ordinary in size, complexity, length, difficulty or alignment. Further, each of these projects is duplicated many times over in the other districts of the State each year.

As on any construction project, problems were plentiful and troublesome. Grading inspectors learned that deposits of gypsum, in the form of selenite crystals occurring in the area, were accompanied by clay silts and shales that had a nasty tendency toward instability as cut slopes. Substantial additional excavation operations had to be undertaken on both larger projects to handle fairly major slides that developed in such material. Relocation of a rancher's proposed approach road was also necessitated by one of these slides.

The immediate effect of this last tricontract construction surge was to eliminate some 17 miles of twisting, narrow, structurally inadequate pavement, high in accident potential, expensive to both the traveling public in time loss and operational expense, and the Division of Highways, whose constantly strained maintenance budget could not afford the constant drain of the pyramiding maintenance costs on the old road. Polonio Pass, where violent twists and dangerous grades have, for years, acted as deterrents to through commercial traffic, has been tamed to the point of being merely the crest of one of the safest and most economical routes to the coast of Central California.

During the past fiscal year the Division of Highways established 173 speed limit zones on 120 miles of state highway.

Bridge Engineer Wins Traffic Scholarship

Allen M. Rubinstein, assistant bridge engineer at Division of Highways Headquarters, Sacramento, has been awarded an Automotive Safety Foundation Fellowship at Yale University for the academic year 1960-61. The award includes $2,200 to help defray tuition and living expenses while studying at the Yale University Bureau of Highway Traffic in New Haven, Connecticut.

Rubinstein attended schools in New York before entering the U.S. Army Corps of Engineers in 1952. Following his discharge, he enrolled at the University of Southern California from which he received his B.A. in 1957. He began work for the Division of Highways in 1957.

Full Freeway

San Bernardino Freeway Now Continuous for 60 Miles

By W. H. CRAWFORD, District Construction Engineer



On March 3, 1960, interchanges were completed and opened to public traffic on U.S. Highway 70-99 at Cherry, Citrus, and Cedar Avenues, which marked completion of construction on the San Bernardino Freeway necessary to convert this modern Los Angeles to San Bernardino highway from expressway to full freeway status.

Public traffic using the San Bernardino Freeway can now travel its entire length of 60 miles with no stops for signals or interference with cross traffic. The San Bernardino Freeway extends eastward from the Santa Ana Freeway near the Los Angeles Civic Center via US 70-99 to a junction with the Riverside Freeway east of Colton, and thence north via US 91-395 to its termination at State Sign Route 30 (Highland Avenue) in the northerly part of the City of San Bernardino. The 60.2-mile length of the San Bernardino Freeway is nearly equally divided between Los Angeles County and San Bernardino County. The portion in Los Angeles County (30.6 miles) was completed in 1956.

Improvements Necessary

Although construction of this important highway to full freeway standards has been accomplished as rapidly as availability of funds would permit, the demands of traffic have already made numerous improvements necessary. Many improvements have been made to the original freeway construction in Los Angeles County since the completion of that portion in 1956. At the present time, widening from four lanes to six lanes between the Los Angeles county line and 5.7 miles westerly is under contract to Matich Constructors and W. F. Maxwell Co. Other projects nearer Los Angeles, providing for widening from six lanes to eight lanes, will be under construction this summer. In District VIII, plans for widening from four lanes to six lanes between Los Angeles county line and Vineyard Avenue, a distance of 6.8 miles, are now being prepared. Also, a diamond interchange and an overhead over the Southern Pacific Railroad at Pepper Avenue, one mile west of Colton, are being prepared for construction this year in co-operation with San Bernardino County.

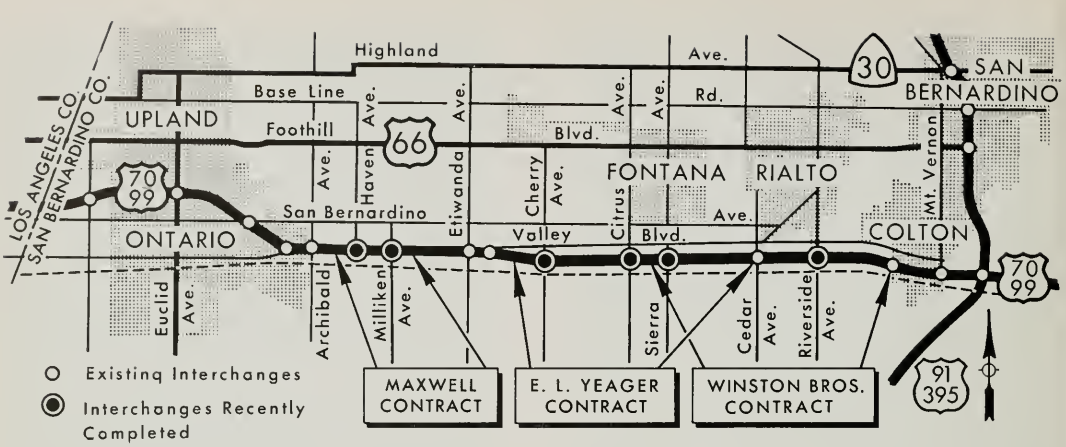
The previously mentioned construction at Cherry, Citrus, and Cedar Avenues, which made it possible for this highway to be operated as a full freeway for its entire length, was a part of a carefully planned program providing near simultaneous construction of interchanges at three locations on US 70-99. These locations, each covered by a separate contract, were at Haven and Milliken Avenues; at Cherry, Citrus, and Cedar Avenues; and at Sierra and Riverside Avenues.

Maxwell Contract

The final stage of converting this expressway to full freeway was started on October 30, 1958, when a contract was awarded to W. F. Maxwell Company of Fontana. This project at Haven Avenue and at Milliken Avenue, 2.05 miles in length, consisted of overcrossings and interchange ramps. Each bridge had precast, prestressed concrete girder spans, with composite reinforced concrete deck, supported on reinforced concrete bents and abutments. The use of precast girders rather than the conventional type of reinforced concrete girders requiring



Cherry Avenue overcrossing is in the center of the picture; Cherry Avenue railroad overhead is to the left of it. These structures and approaches replace the former grade crossing at this location.



falsework for their construction, provided safer passage of public traffic through construction.

Girder erection was permitted only between the hours of midnight and 5 a.m. During these hours, traffic was blocked for periods of time not exceeding 30 minutes for the purpose of erecting girders. Sufficient time was allowed between such periods to allow accumulated traffic to clear.

The work of precasting and prestressing the girders was performed by the contractor on the job. Girders were transported to the bridge site as needed. Two truck cranes, one operating at each end of the girder, were used to transport the girders and erect them to position on the abutments and bents. The contractor was well skilled in this operation and succeeded in erecting the girders in the average time of approximately 20 minutes each. Sixty-four girders in all, ranging from 33′9½″ to 83′1″ in length, were erected. The best production was the erection of 16 girders in a four-hour period.

Traffic Inconvenience Slight

The short erection time proved to be but slight inconvenience to public traffic, which was light during the after-midnight hours when erection of girders took place.

Other work on the project, including ramp construction, highway lighting, and drainage revision, was performed without interruption to public traffic. The importing of 339,000 tons of borrow material, which was used in the construction of bridge approaches, might have caused inconvenience to traffic had it been necessary to haul this material on or across the freeway. By obtaining material sites on each side of the freeway, and by the use of a well-planned hauling scheme, the contractor was able to place the material in its final position in the roadway embankment without necessity of hauling on the freeway.

The imported borrow used was obtained from three material sites located near the project. All of the sites were graded to predetermined elevations and are an improvement to the area. One site when completed was contour-graded to conform to surrounding terrain, another developed an industrial site, and the third opened up a flood control channel.

The project was completed August 28, 1959, at a cost of $639,940. H. F. Strahm was the resident engineer.

Winston Bros. Contract

The next project to be completed was a contract awarded to Winston Brothers Company on December 3, 1958.

This project, 4.43 miles in length, between Sierra Avenue and the City of Colton, consisted of freeway overcrossings and railroad overheads at Sierra Avenue and Riverside Avenue, and interchange facilities.

There being insufficient distance between the existing traveled way and the railroad to construct complete interchange facilities at Sierra Avenue and Riverside Avenue, it was necessary to realign and reconstruct the existing expressway to provide space for ramps between the freeway and railroad. Pavement and other facilities were constructed on new curved alignment with a minimum radius of 5,000 feet for over 3,300 feet at each interchange location. To better control the access to the freeway, existing barbed-wire fence along the right-of-way was replaced with 72″ chain-link fence throughout the project.

Fifty-two precast, prestressed concrete girders, each 68′2″ in length, were used in the construction of the overcrossings, and 30 precast, prestressed concrete girders, 81′0″ in length, were used in the overhead structures. All of the precast, prestressed concrete girders were fabricated by the Concrete Conduit Company of Colton, and were transported to the job by trucks. Erection of the girders at the bridge site was accomplished by simultaneous effort of two truck cranes, one operating at each end of the girder. Handling of the 81-foot-long girders above the Southern Pacific Railroad tracks at the overhead structures was a well-coordinated operation, completed without incident or interference with train movements.

Daylight Work

Differing from the method used on the previous project, the girders for the Sierra Avenue and the Riverside

Avenue overcrossings were erected during daylight hours. Conditions being favorable and there being adequate space, temporary detours were constructed around the bridges for handling of traffic. Use of the temporary detours applied only between the hours of 9 a.m. and 3 p.m. on the day girders were erected. That time was selected for operation of the detour as the traffic volume for those hours was less than during any other six-hour period during daylight hours.

Except for the material used in the construction of the south bridge approach to the Riverside Avenue overhead, where a haul road outside the traveled way was possible, all imported borrow was hauled by truck over county roads and along the freeway to its point of use. Other than the slight nuisance of heavily loaded trucks traveling on the freeway, there was no interference with public traffic by reason of construction on this project.

This project was completed on October 22, 1959, at a cost of $1,610,973. Arthur W. Nelson was the resident engineer.

Yeager Contract

The last of the three projects completed on the San Bernardino Freeway was that awarded to E. L. Yeager Company on December 3, 1958, and completed March 3, 1960.

This project, 5.51 miles in length, between Mulberry Avenue and Cedar Avenue, converted the remaining section from expressway to full freeway status. Diamond-type interchanges were constructed at Cherry Avenue and at Citrus Avenue, overhead crossings of the Southern Pacific Railroad at these streets were constructed, an offramp at Cedar Avenue was reconstructed to higher standard, drainage structures were revised, and better control of access was obtained by replacing existing property fence with 72-inch chain-link fence.

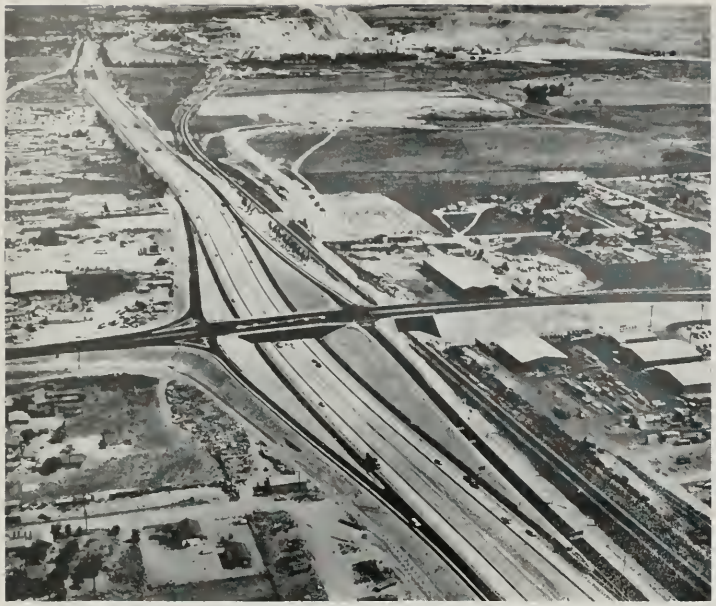
To obtain space for interchange construction at Cherry Avenue and Citrus Avenue, it was necessary to realign the existing expressway outward from the Southern Pacific Railroad, which is parallel and adjacent to the south right-of-way line of the



MIDNIGHT CONSTRUCTION—Under the glare of auxiliary spotlights, workmen manned heavy equipment to lift precast prestressed concrete girders into position at the three-level interchange of San Bernardino Freeway at intersection of US 70-99, with US 91-395. Work on this sector was performed at midnight December 17, 1958, as traffic on the freeway was halted for short periods. (Photo by San Bernardino Sun-Telegram.)



Citrus Avenue Overhead during construction after erection of precast prestressed concrete girders, showing near absence of falsework and minimum of interference to train movements. (Photo by San Bernardino Sun-Telegram.)



Recently completed Riverside Avenue interchange and freeway on US 70-99. Looking east.

highway. Thirty-five hundred feet of existing pavement at Cherry Avenue and at Citrus Avenue were realigned in the same manner as at Riverside and Sierra Avenues.

Forty-four precast, prestressed concrete girders, 68 feet 2 inches long, were used in the construction of the overcrossings, and 16 precast, prestressed concrete girders 111 feet long, and 12 precast, prestressed concrete girders 81 feet long were used in construction of the overhead structures. The girders were fabricated by the Colton Conduit Company at their Azusa plant, and were transported to the job by truck. Erection was performed by use of truck cranes. Detours were available to route traffic around the overcrossing structures between the hours of 9 a.m. and 3 p.m. on the days girders were erected. At other times, traffic was afforded clear and unobstructed passage through construction.

No Borrow Hauling

Construction of embankments for ramps and bridge approaches required importing 793,000 tons of fill material. No hauling of imported borrow across the freeway was necessary as sources of material were available on each side of the freeway. This method of construction, whereby imported borrow was brought in from each side of the freeway for bridge approach and ramp construction, resulted in virtually no interference to through traffic on the freeway.

This project was completed at a cost of $1,665,071. The resident engineer was Calvin Mauck.

The completion of these three projects within a period of 16 months removed the last vestiges of the expressway type of highway from a 16½-mile section of the San Bernardino Freeway and removed the hazardous traffic conditions that existed at the six at-grade intersections of the expressway and the four grade crossings at the SPRR.

The new construction also brought about complete control of access to the freeway and provided up-to-date signing conforming to latest standards for Federal Interstate Route 10.

Bridge Toll Machines Removed After 1 Year

The two automatic toll collection machines which have been in operation experimentally on the San Francisco-Oakland Bay Bridge for the past year were removed in May.

State Highway Engineer J. C. Womack said the machines did not prove substantially advantageous as far as expediting the heavy traffic on the bridge was concerned.

"We can see from our year-long trial period where automatic toll collection equipment has probably been helpful on certain toll roads," he observed. "But on the Bay Bridge, where a substantial portion of the traffic uses commute tickets, we appear to be better off in the long run with manual collection."

The machines were installed in one eastbound lane and one westbound lane at the Bay Bridge toll plaza, with the thought that if they proved advantageous they might be installed in additional lanes. The experimental installations were marked with signs restricting their use to motorists with the exact 25-cent change.

Under heavy flows of traffic, particularly at commuter peak hours, Womack said, there were indications that multiple automatic toll collection lanes would not work uniformly well and might actually cause congestion and accident hazard. He noted that the Triborough Bridge Authority in New York had discontinued the use of automatic toll collection equipment on the Bronx-Whitestone Bridge after a similar trial.

"We are proud of the reputation of our toll collectors and other bridge employees for efficiency, courtesy, and service to the motoring public," Womack said. "However, we will continue to look into all possible methods of increasing the economy bridge operation and of expediting traffic."

California freeways, rural and urban combined, had a fatality rate of 2.83 per 100 million vehicle miles for 1958 as compared with the 1957 rate of 3.62.

Slipform Paving—L.A.

New Technique Used On Harbor Freeway

By R. M. INNIS, Senior Resident Engineer



THE FIRST slipform paving on a major freeway in metropolitan Los Angeles was recently completed by Ukropina, Polich, & Kral and J. E. Haddock Ltd. on the Harbor Freeway between 124th Street and 190th Street. Besides introducing this type of slipform paver, this is the first time that keyways, tiebars, and adjacent lane paving have been performed by the slipform method in California.

The slipform paver utilized was manufactured by a well-known midwestern equipment manufacturing firm, and has been in use for several years on highway construction outside of California. This type of slipform paver differs primarily from that used in the northern part of the State (reported on in the January-February issue of this magazine) in that the vertical alignment or grade is not dependent upon a wire and electronic sensing devices. This machine depends instead upon the smoothness of the subgrade and the straightedge characteristics of the 22-foot tracks to obtain the required smoothness. The screed or extrusion meter, as it is termed, is rigidly set for depth of pavement required. Therefore it is readily evidenced that



Slip form pover being fed by twa dual-drum cancrete paving mixers. Man standing an platform in front af machine is placing center tiebars.



Concrete being placed in front of slip form paver in position for initial strike-off by hydraulically operated screed. Screed is in its rearmost position.



The screed is now at its forword limit of travel. The position of the 10 internal vibrotors will be noted behind the screed.

a good subgrade is of prime importance.

Cement-treated Subgrade

The typical section for this portion of the Harbor Freeway provides two 48-foot concrete roadways. The outer 24 feet of each roadway is 9-inch pavement and the inner lanes 8 inches. Underlying the concrete pavement is 4 inches of cement-treated subgrade. The untreated base for the cement-treated subgrade is of ¾ inch maximum aggregate.

Construction Staking

Grade stakes to top of the cement-treated subgrade were offset three feet from the edge of pavement and set at 25-foot intervals along line for both sides of the 24-foot lane. One line stake and marker lathe indicating the percent of crossfall were also set every 25 feet. For the initial 24-foot lane on the roadway the contractor cement-treated 27 feet wide. This not only provided a stable track path for the slipform paver but also cleared the tiebars necessary for the adjacent lane. The tiebars used were 30-inch lengths of ½-inch round reinforcing steel.

The contractor, J. E. Haddock, used three sets of working hubs before the cement-treated subgrade was complete. The first set was placed to balance the material, the second set was placed four inches down to check the bottom of the cement-treated subgrade after initial windrowing, and the final hubs were set to the top of the cement-treated subgrade for final grade after mixing.

Production Averages

Utilizing one traveling pugmill road-mixer, one standard motor grader, and one motor grader equipped with automatic blade control, the contractor averaged 3,500 lineal feet or 94,500 square feet of cement-treated subgrade per day. Compaction was obtained by the usual steel and pneumatic wheeled rollers. With the crossfall percentage noted on the marker lathe, the blade operator using the automatic blade control could easily negotiate the transitions and superelevations.

Close Tolerances

The completed cement-treated subgrade was then profilographed each day using the California Profilograph.

The average reading for the job is 6.5 inches per mile. The smoothest cement-treated subgrade profilographed at 3.1 inches per mile. As can be noted, the subgrade average is under seven inches per mile specified for the concrete pavement surface.

Description of Paver

The paver, weighing approximately 38,000 pounds, travels on two tracks each 22 feet in length. Each track is powered by a three-h.p. D.C. variable-drive motor. This enables the operator to regulate the speed of each crawler track to maintain alignment. Steering is guided by a plumb bob over a string line. The paver's primary power source is a 32-h.p. four-cylinder air-cooled engine driving a hydraulic pump and a 10-k.w. generator.

Now to follow the concrete through the machine. The concrete is placed on the grade between the front wings or sideplates of the slipform paver by two standard dual-drum paving mixers. The concrete is initially struck off by a 24-foot hydraulically operated screed having five feet of fore and aft travel. This is operated by the slipform paver operator and is used to balance the concrete evenly across the front of the machine. Also, this screed has vertical manual adjustments which are used in superelevations.

Internal Vibration

Behind the strikeoff, and in front of the extrusion meter, the concrete is vibrated by a series of 10 variable-frequency internal spud-type vibrators. These operate submerged approximately 2½ inches above the subgrade and are powered by a separate 180-cycle A.C. motor generator. No difficulty was encountered in obtaining concrete of specified density.

Behind the vibrators and immediately in front of the extrusion meter is a tamper bar. The tamper bar works to a lower limit of approximately one-fourth inch below the leading edge of the extrusion plate and insures that large aggregate particles are tucked under the screed plate without leaving tears in the completed surface.

Controlled Edge Slump

The extrusion meter is a 42-inch-long by 24-foot-wide steel screed plate. The front edge is rounded and set approximately one-half inch higher than the trailing edge which is set to grade. The exact amount of pitch, which is adjustable, is dependent upon the mix design, water content, etc. The outer six inches, measured transversely, of this plate are adjustable and were turned up from three-eights to one-half inch. This compensates for mortar loss and resulting edge drop in the trailing forms. By adjusting the edges of the extrusion plate, mortar loss and edge drop can be compensated for and a true section obtained. Behind the extrusion meter the surface is given a belt finish by a 24-inch oscillating rubber belt.



Closeup showing method used to insert keyway section in front of slip form paver. This is done only on initial lanes.

Trailing Forms

The contractor started using two 16-foot sections of trailing forms at each edge of pavement; however, after the operation smoothed out, only one 16-foot set of trailing forms on each side was found to be necessary. The need for trailing forms is only that of having time for edging and such handwork as is necessary. The machine, extrusion meter, and trailing forms are all set 24 feet wide with no appreciable narrowing of the section at any point.

Along the latter portions of the job the contractor attached a chevron float behind the machine which operated between the trailing forms. This improved the smoothness and reduced the labor of the hand finishers.

Companion Lane

The companion or adjacent lane paving posed no great difficulties. The paver was blocked up and one crawler track rode the existing slab. One 16-foot trailing form was used and was diagonally supported to the back frame of the slipform paver by a spring-loaded truss.

Tiebars No Problem

As mentioned in the initial part of this article, keyways and tiebars were placed. The keyway sections, 20 feet long and drilled at 30-inch centers,



Rear view of slip form paver showing chevron float in operation.

were wired together on the grade and inserted into keeper plates or rods fastened to the side of the paver. The slipform machine then traveled forward with the keyways passing on through. A four-foot length of slotted trail form was attached to the end of the trailing form on the machine. As the keyway passed through, the straight tiebars were manually inserted in the holes of the keyway. The center tiebars were placed manually in the concrete by a workman and a platform mounted on the front of the slipform paver.

Edger tools attached to the end of the trailing forms performed the initial edging. A finisher on each side of the machine hand-floated the edge just prior to the edger tool. With some additional modification on the chevron float and trailing forms it is hoped to eliminate the hand floating at this point.

Edging Fresh Concrete

Behind the machine, finishers checked the slab longitudinally with 14-foot lightweight floats or straightedges. Any large irregularities were taken out by finishers using a large bull float from portable bridges across the slab. This work during the latter portions of the job was at a minimum. The usual final edging and burlaping was then performed. Curing compound was mechanically applied by a machine straddling the slab and all joints were sawed.

The production with two mixers has been as high as 2,000 cubic yards per day and the profilograph on the pavement surface has averaged below six inches per mile with the lowest at 2.8 inches per mile.

Water Content Important

Many factors besides good subgrade govern the smoothness; for example: constant water content, steady progress of the machine, and proper placement of the concrete in front of the slipform.

Contractor's representatives were H. Rollston, superintendent, Roy Bennett, foreman, and head finisher Lee Martin.

State-owned Toll Bridges Show Traffic Gain

Traffic on all five San Francisco Bay area state-owned toll bridges showed substantial increases in April 1960 as compared with April 1959.

The greatest percentage increase was on the Dumbarton Bridge which was up 21.29 percent. The San Mateo-Hayward Bridge was second with an increase of 19.04 percent over this time last year. The Carquinez Bridge was up 14.25 percent and the Richmond-San Rafael Bridge showed a gain of 13.54 percent. San Francisco-Oakland Bay Bridge, the most heavily traveled of the structures, had a traffic increase of 3.07 percent.

Total vehicular traffiic on the bridges for April of 1959 and 1960 was as follows:

Dumbarton Bridge—April 1959, 150,196; April 1960, 182,181.

San Mateo-Hayward Bridge—April 1959, 276,435; April 1960, 329,063.

Carquinez Bridge—April 1959, 883,-450; April 1960, 1,009,347.

Richmond-San Rafael Bridge—April 1959, 235,618; April 1960, 267,516.

San Francisco-Oakland Bay Bridge —April 1959, 3,077,229; April 1960, 3,171,783.

Rio Vista Bridge

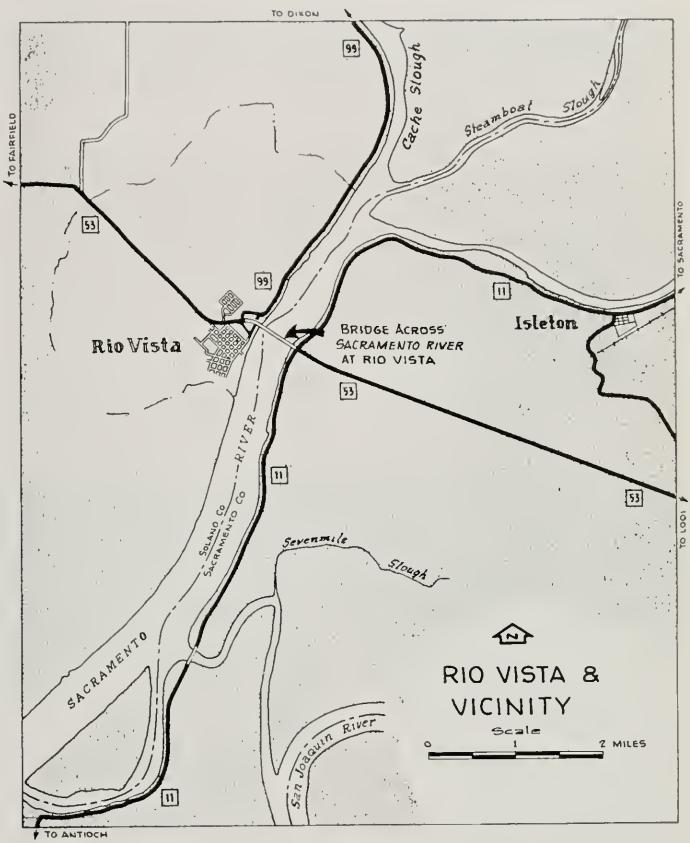
Modern Lift Structure Spans Lower Sacramento



Long awaited by residents of Rio Vista and nearby towns, is the completion of the new bridge structure across the Sacramento River at Rio Vista.

In opening ceremonies sponsored by the Rio Vista Chamber of Commerce featuring speeches by Lieutenant Governor Glenn M. Anderson, Senator Luther E. Gibson of Solano County, and T. F. Bagshaw, Assistant Director of Public Works, the bridge was opened to traffic on April 1, 1960.

This description of the Rio Vista Bridge project was prepared by G. W. Smith and G. D. Gilbert, Senior Bridge Engineers, E. F. Van Zee, Associate Bridge Engineer who was also resident on the job, and S. J. Robinson and R. T. Fuller, Associate Bridge Electrical and Mechanical Engineers.



It is a highly important link in the realigned portion of the State Sign Route 12 which extends from Rio Vista to the Mokelumne River some three miles east. Route 12 is the most direct route from the delta region to the San Francisco Bay area. During the harvest season a large amount of produce is trucked over this route from the adjacent farming country.

Peak river traffic occurs during the summer months. As many as 780 bridge openings have occurred during the month of September, which is an average of 26 per day.

Upon completion of the Sacramento Deep Water Channel Project, ocean-going vessels will be passing through this structure plying their trade between world ports and the Sacramento Valley.

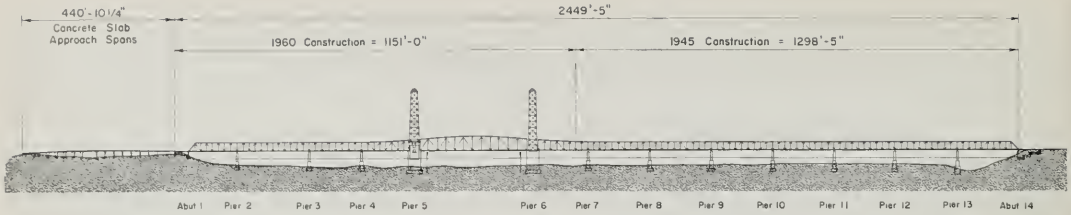
East Portion Completed

The year 1945 marked the completion of the easterly portion of the new structure wherein some 1,300 feet of steel trusses were constructed. Approval for construction of the final portion of the bridge was given by the U.S. Corps of Engineers on February 2, 1950.

Moneys were made available for financing the final portion in the 1958-59 fiscal year. Cost of the 1945 portion of the structure was $730,000, which with the $3,370,000 cost of the present project added, makes the total cost of the bridge $4,100,000.

Completion of the present contract marks the complete replacement of an old structure which was built in 1918. The old structure contained several types of spans, a 70-foot concrete tied arch, a 343-foot Strauss double-leaf bascule, three 120-foot concrete tied arch spans, and approximately 1,670 feet of timber A-frame trestle spans.

In 1945, the old timber A-frame spans then in poor condition were replaced by a series of 180-foot steel truss spans on a new alignment located 60 feet upstream from and parallel to the old bridge. A crossover for traffic was constructed between the truss spans and the westerly portion



ELEVATION

of the old structure, so that from 1945 to 1960 a combination of new and old structure was used.

The recently constructed portion of the main structure is about 1,150 feet long and extends westerly from the end of the truss spans constructed in 1945. It was handled in two contracts, one for the substructure and one for the superstructure. The total length of the completed main structure is 2,446 feet. The superstructure contract also included the construction of an approach structure located immediately west of the west abutment consisting of 441 feet of continuous concrete slab spans. The substructure contract amounted to $960,000 and the superstructure contract including the slab approach spans on the west end $2,410,000. Cost of the 441 feet of slab approach spans alone was $124,000.

The new structure has a 26-foot roadway with a four-foot sidewalk on each side. Minimum vertical clearance for vehicles in the truss spans is 15 feet.

The new 306-foot lift span across the river channel provides a 270-foot clear opening for navigation between fenders. In the up position it allows 135 feet vertical clearance above flood plane elevation of 12.80.

Substructure Contract

Construction on the substructure contract was started on April 2, 1957.

Piers for the approach spans consist of two tapered concrete shafts connected at the top by a concrete web wall. Each shaft rests on a 14-foot-diameter circular footing which is founded on 16-inch-diameter prestressed concrete piles. Each footing has a nine-foot-thick tremie concrete seal. Design load for each of the piles is 45 tons.

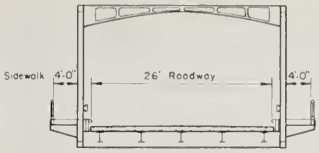
In the construction of the circular shafts of the truss piers a heavy steel sheet pile cofferdam was used for each shaft up to the bottom of the connecting web walls, which is just above normal high tide elevation. The pier shafts were formed with circular steel forms which were previously fabricated and used in the construction of the piers for the easterly half of the bridge in 1945.

The towers No. 5 and No. 6 consist of cellular concrete shafts 36 ft. x 42 ft. in outside dimensions. They are divided into three cells. Each pier is founded on a footing 46 ft. x 53 ft. and 10 ft. 6 in. thick, 7 ft. 6 in. of which is a tremie concrete seal. Under each footing are 145 prestressed concrete piles. For these piers, the contractor constructed a 48 ft. x 54 ft. steel sheet pile cofferdam heavily braced with five frames of welded steel "H" pile sections. The 7-ft.-6-in. thick layer of concrete was placed by means of two tremie tubes to seal the bottom of the cofferdam to permit dewatering. The 1,100 cubic yards of structural concrete required for the tower piers was formed and placed using conventional methods. Concrete for all piers was delivered to the job site on the parallel existing bridge by transit mix trucks. One-way traffic control on the existing bridge was employed while the transit trucks were unloading.



A view of the bridge roadway looking westward.

To drive the 145 16-ft. octagonal prestressed concrete piles for each pier, the contractor used the same method which was used in driving the steel H piles for the easterly piers. This method employed a steel pipe slightly larger than the concrete pile to guide the pile while it was being driven. To locate the pile accurately, a steel template frame was attached to the top cofferdam frame. The bottom of the pipe was imbedded slightly in the sandy bottom and was held in place by the template at top. The concrete pile was then placed inside of the pipe and driven to bearing with a steam pile hammer using a specially constructed steel H pile follower. To get the concrete piles down to the specified tip elevation, the contractor used two 4-inch jets supplied by a three-stage, 500-psi., 600-g.p.m. pump. The substructure contract was completed October 30, 1958.



TYPICAL SECTION

Superstructure Contract

The superstructure contract consisted of placing 1,150 feet of steel truss spans and, in addition, the 441 feet of slab approach spans.

Flanking the lift span are five steel truss spans (one on the east end and four on the west end). The trusses were designed to look like those constructed in 1945 yet including latest features and methods wherever possible. The web members in the new Warren-type trusses mainly consist of rolled wide flange sections. Top and bottom chords consist of two 15-inch channels connected by lacing and stay plates. Connections for these members are riveted, with some uses being made of high-strength bolts.

Lift Span Described

The lift span has an appearance of striking simplicity. This is accomplished by the use of the tower drive. The operator's house is located on Pier 5 with the operating machinery placed in the tops of the towers.

A curved chord Warren-type truss was used to carry out the same general appearance as the other truss spans. All of the main members are built up from channels, plates and wide flange sections, for easy painting access. Floorbeams, as in the approach spans, are 36-inch wide-flange sections. Stringers are wide flanges, supporting a lightweight concrete deck.

At one end a seating detail guides the lift span both laterally and longitudinally; at the expansion end it is



Looking west toward Rio Vista along the upstream side of the completed structure.

guided laterally only. Weight of lift span is 1,550,000 pounds.

Towers on Main Piers

Each tower consists of four legs connected by struts and lateral bracing. The towers are independent of the approach span trusses as they set directly on the main piers. The prominent feature of the tower legs is the accessibility for painting. In the main the legs consist of plates welded together to form a four-point star. Stiffener plates are placed on the legs at approximately 6-foot centers.

Stainless steel rails conforming to ASTM A-176 Grade 2, annealed, finish No. 2D, are attached to each tower leg as tracks for the rollers.

Sheave guards are placed over each of the 14-foot diameter sheaves.

The highest points of the towers are approximately 210 feet above mean low water. Each tower has an automatic electric elevator providing easy access to each tower top and also has a stairway the full tower height.

Counterweights, consisting of heavyweight concrete poured around a steel frame, balance the weight of the lift span. Unbalanced condition of the counterweight ropes are taken care of by balance chains in each tower. In each counterweight, open holes are provided for placing balance blocks to take care of possible future changes in the weight of lift span. Hanger plates are provided for anchoring the counterweights in the up position for future rope replacement.

Control House

The operator's house, a concrete structure which houses control equipment, is located in the south side of Pier 5. It consists of three floors. The lower floor in conjunction with space under the roadway encloses standby equipment and provides for storage. The next floor, at roadway level, houses the electrical switchboard equipment. The top floor includes the operator's house with the control panel and interlocking equipment for controlling roadway traffic. It has been designed to give a clear view to both river and roadway traffic, and thus provide a maximum of safety. Concrete stairways give access to the various floors of the house.

Construction Features

Work started on the superstructure contract on April 24, 1958, with the ordering of structural steel from the mills. The first order of steel erection was the east tower, which started on December 4, 1958.

All structural steel was erected with the use of a steam-operated floating tower derrick crane which could lift 100-ton loads up to a height of 205 feet above water elevation. The north and south faces of the towers were erected in preassmbled 33-foot-high sections weighing approximately 32 tons each. The steel members for the east and west faces of the towers were erected concurrently with the erection of the preassembled sections.

Erection of the two 14-foot-diameter 10-ton sheaves complete with their bearings on top of the towers required the help of high tide to obtain the necessary height of the derrick crane boom.

Each of the 140-foot approach span trusses were erected in complete preassembled individual span units by the floating tower derrick without falsework. The lift span was erected in 102-foot preassembled truss sections supported on falsework bents at the third points of the span. After the trusses for each span were erected, the lateral bracing and deck system steel members were erected and connected to the trusses.

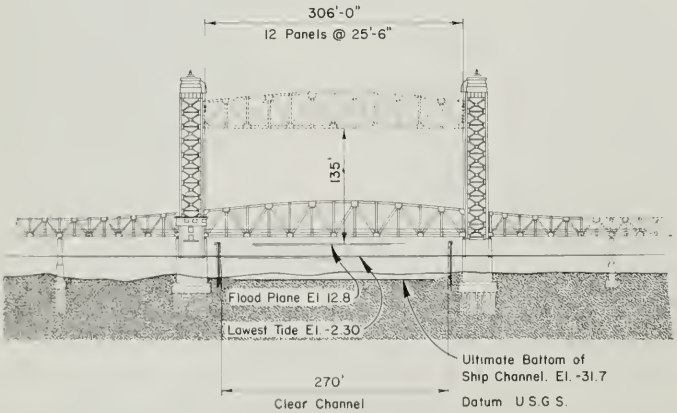
The contract plans allowed the option of rivets or high-strength bolts for all structural steel connections. The contractor used rivets for all shop connections and high-strength bolts for field connections.

All preassembled tower sections and truss units were assembled in the contractor's Richmond, California, yard and barged to the job site. The contractor did not have a work yard at the bridge site because of the limited space available.

Concrete required for the control house and roadway deck was formed and placed using conventional methods. Concrete for the lift span deck consisted of lightweight concrete weighing 98 lbs. per cubic foot with a one-half-inch topping of grout weighing 138 lbs. per cubic foot. Aggregate for the lightweight concrete was expanded shale.

Counterweight Construction

The counterweight in each tower was constructed in the up position linked to the sheave beams at the top of the towers. In order to balance the weight of the lift span, the concrete for the counterweights weighs 216 lbs. per cubic foot. Aggregate for this heavyweight concrete was magnetite (an iron ore) having a solid weight of 275 lbs. per cubic foot. This aggregate was obtained from a source near Lovelock, Nevada. To form and place



ELEVATION—LIFT SPAN

concrete for the counterweights at a height of 141 feet above the roadway required some ingenuity on the part of the contractor. The solution consisted of constructing a bottom form, hung from the structural steel frame of the counterweight, to support the weight of a two-foot layer of concrete. After obtaining the proper strength, the bottom two-foot layer of concrete served as a support to carry the construction weight of the remaining 15-foot height of counterweight.

Connection of the 40 two-inch-diameter wire lifting ropes to the counterweights and lift span was accomplished by jacking up the lift span approximately two feet with hydraulic jacks at the four corners of the span and at the falsework bents. After all lifting ropes were connected, the jacks were released and the lift span was lowered to raise the counterweights slightly to permit the removal of hanger link pins and thus free the counterweights from the sheave beams. All lifting ropes were then adjusted by means of the anchoring eyebolts to within 2 percent of equal tension.

Handling Traffic

During bridge construction it was necessary to maintain unobstructed flow of vehicular and waterborne traffic.

When in 1944 plans were prepared for the easterly 1,300 feet of the structure, pier locations and length of structure were based on no change in location of the navigable channel. However, when plans for the Sacramento Deep Water Channel were being formulated in 1947, the Corps of Engineers requested that the centerline of the new navigable channel be located some 575 feet to the east of the existing. This necessitated reconstruction of the vehicular crossover used since 1946 and the development of a new plan for handling traffic.

Available roads for vehicular traffic during periods when structure was closed would have entailed long detours over substandard roads. The cost of signing and maintenance of these roads would have been excessive and the circuity of these detours would have been very time-consuming as



A view downstream shawing the lift span raised.



A view upstream showing the lift span lowered. The control house is on the pier to the left.

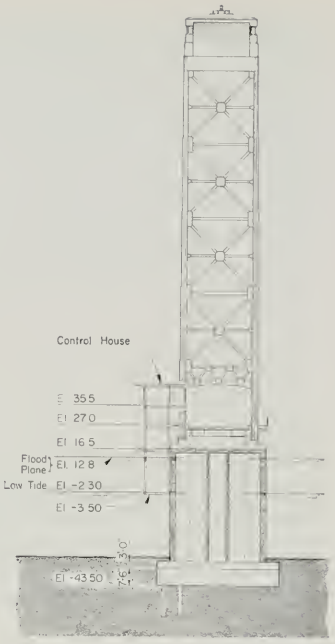
well as annoying to motorists. Good engineering practice dictated the use of crossover structures connecting the old and new construction to properly handle vehicular traffic.

The crossover in use since 1946 and the beginning of this contract could not be used due to relocation of the deepwater channel. It interfered with construction of tower Pier 6.

To carry out the planned stage construction, two crossovers of timber and steel were constructed to handle vehicular traffic—No. 1 east of the new lift span, and No. 2 west of the lift span. Both of these were quite ingenious, since they required entrance through the side of existing spans. On crossover No. 1, one side of the existing truss span was supported on timber pile bents, and the top chord and lateral bracing supported by a strongback placed over the top chord. Five panels of the truss, along with about 180 feet of sidewalk were removed to provide adequate roadway clearance for entry to the truss roadway.

After completion of the new lift span and timber fenders, crossover No. 2 was constructed. This involved entry through the side of an existing concrete tied-arch span. Several hangars between the arch and roadway were removed, and pile bents and steel needle beams placed to support the roadway.

Upon completion of crossover No. 2, traffic was routed over it and crossover No. 1 was removed. This allowed for removal of the easterly portion of the old structure, routing of water traffic through the new lift span, and completion of the new truss over the old navigable channel.



TYPICAL SECTION
PIER 5

Mechanical Features

The lift span is driven by a 30-horsepower motor located in each tower. The fact that only 60 horsepower is required to operate 3,000,000 pounds of lift span and counterweights is due in a large part to the use of antifriction bearings to support the counterweight sheaves. The use of bronze bushing-type bearings would have required a 75-horsepower motor in each tower. This saving of 90 horsepower represents a saving of $650 per year in fixed connected horsepower charges alone.

The counterweight rope sheaves are of arc-welded construction, weigh 10 tons each and are 14 feet in diameter. The lift span and counterweights are connected by 40 two-inch-diameter wire ropes each having a minimum breaking strength of 320,000 pounds.

Each counterweight sheave is supported by two spherical roller bearings having internal bores of 16½ inches and outside diameters of 25½ inches. Each bearing supports a dead load of 400,000 pounds.

To guard against a possible failure of utility power a diesel-engine generator set was installed. The 100-kilowatt generator is powered by a 167-horsepower diesel engine.

The lift span is guided during its travel by rollers which move on stainless steel rails fastened to each tower leg. Like the rails, the rollers are also stainless steel and have self-lubricating bronze bearings for maintenance-free operation.

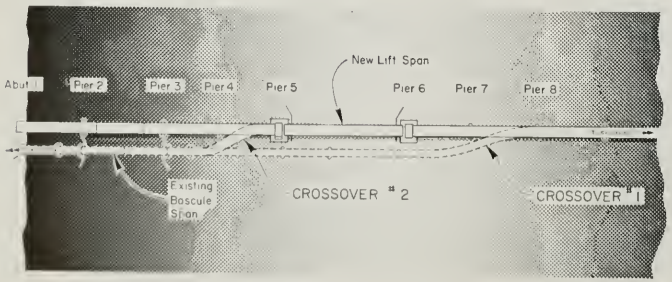
In addition to the stairway, each tower has an electrically operated three-passenger elevator which travels from just above the roadway to a landing below the machinery deck.

Positive post-type barriers which protect roadway traffic from running off the bridge when the lift span is up are mounted below the deck of the approach spans. Each post is driven up and down by a hydraulic cylinder with a stroke of 37 inches. There are also roadway gates and pedestrian gates to protect the public during the period the span is up.

Electrical Features

Accurate stopping and seating of a lift span is one of the most important, yet tedious and time-consuming jobs imposed upon an operator. With this in mind, the electrical control features of the bridge were designed to make the bridge operation automatic. This allows the operator to be free of the mechanical details of span control and more properly give his full attention to control of traffic.

To these ends an automatic span control was developed of the closed-loop type. To raise the span the operator simply holds down the "raise"



DETOUR PLAN - TRAFFIC

button on his control console. In response, the span control automatically accelerates the span upward, within the first six feet of travel, to an accurately controlled normal speed of 90 feet per minute.

The span can be raised to the fully open position in just less than 90 seconds. Near the top of the travel, through a series of limit switches, each creating a demand for reduced span velocity, the controls slow the span to a smooth stop. The brakes are then set automatically.

By holding down the "lower" button the span can be returned to the seated position. However, in seating, the span controls perform an additional function to those described for raising.

After the span has reached all four seats the span control automatically drives the span tightly against the seats and then sets the brakes. The operator may then release the "lower" button. The object of tightly seating the span is to prevent its bouncing against the seats under highway traffic as it would do if it were simply hanging by the suspender ropes and in light contact with the seats.

To stop the span at any intermediate point between "fully open" and "fully closed" the operator need only release whichever button, "raise" or "lower," is being held down and the span control automatically decelerates the span to zero velocity and sets the brakes. The span may be moved either up or down from any intermediate position.

The span control performs another very important and essential function. It is required to maintain the span in level position at all times. This it does to a high degree of accuracy, seldom permitting more than a fraction of an inch difference in elevation between the ends of the span even though they are 306 feet apart.

At this writing there still remains some removal work of the old bridge. It is anticipated that all work in the superstructure contract will be completed about July 1960.

Lord and Bishop was the contractor for the substructure, and Judson Pacific Murphy Corp., of Yuba Consolidated Industries, Inc., for the superstructure.



Earl Highley, one of the four drawbridge operators on the Rio Vista Bridge, operates the span control panel.

BENICIA-MARTINEZ

Continued from page 39 . . .

will be completely anchored with considerable rigidity to all 10 of the caissons.

From this point on the concrete pier shafts will be constructed by slip forms to the bottom of the steel shoes supporting the main trusses.

Deep Water Pier Design

The sequence of operation is best illustrated in the sketches showing steps 1 to 8, inclusive. Much interest has been shown in this type of deep-water pier design and construction and more detailed information will be available at a later date.

Each pier when completed will be enclosed in a heavy concrete pile protective fender to guard against any possible damage or shock from navigation.

During April 1960, work was in progress at Pier No. 12 which is the second pier out from the Contra Costa County shore. Box footing for the next pier has been completed and ready to be towed to the site. Construction schedule calls for completion of the piers by December 1961.

Steel erection of the Martinez approach girders is to start this summer, and erection of the heavy truss spans is scheduled to start in September or October of this year.

O. A. Johnson, who was resident engineer for the parallel Carquinez Bridge, is in charge of construction activities on the Benicia-Martinez structure, with Wallace Ames again serving as his chief assistant.

IN MEMORIAM

District VII
Merle J. Markland, Highway Equipment Operator-Laborer.

District VIII
Atley T. Moore, Skilled Laborer.

District XI
Kenneth E. Wyatt, Assistant Highway Engineer.

Shop 2
Everett W. Bossuot, Highway Equipment Superintendent II.

State-owned Toll Bridges
John Ribeiro, Laborer.

Almost 43 tons of obsolete records were sold as waste paper by the Division of Highways during the last fiscal year.

McHenry Ave.

State, Modesto Team Up To Widen Congested Road

By JOSEPH J. SPAETH, Assistant City and County Projects Engineer, and F. M. BABCOCK, Resident Engineer



Local citizens, working with and through their municipal organization, and District X of the Division of Highways, traded rights-of-way for a widened highway and a storm drain system. This action expedited the construction of a 1.7-mile section of State Highway Route 109, known locally as McHenry Avenue, and, at the same time, solved a difficult drainage problem of considerable magnitude for the City of Modesto. Approximately $1,300,000 of state highway funds was required for the recently completed street and sewer project. Right-of-way costs were paid from city funds.

The existing situation was a two-lane rural-type road, portions of which were inside the Modesto city limits. "Ribbon-type" commercial development in this urban area had decreased the highway capacity, added to local traffic and aggravated an already unsatisfactory drainage situation which depended upon percolation and evaporation for the disposal of storm water. No natural waterways existed in the area. The highway was subject to average daily traffic movements of 15,000 vehicles. Natural drainage had deteriorated to the extent that the traveled way was partially inundated during heavy rainstorms.

Storm Sewer Planned

To alleviate these conditions, the City of Modesto was planning a storm sewer system for the entire area and the Division of Highways was planning increased highway capacity for McHenry Avenue. The city's plan called for an 84-inch and 72-inch reinforced concrete pipe drain to be placed under McHenry Avenue and the Division of Highways plan called for an increased width of right-of-way and the construction of two additional traffic lanes.

Logically, the situation called for installation of the storm drain prior to improvement of the highway. However, the usual situation of having more worthy projects than available funds with which to construct them prevailed, and the city found it could not finance the cost of the storm drain system within a reasonable period of time.

The city's estimate of cost for constructing the storm drain was equiva-



NOW—McHenry Avenue, looking south toward the Orongeburg intersection, March 1960.



McHenry Avenue, October 1959, while construction operations were under way.

lent to the State's estimate of cost for acquiring the additional rights-of-way for the highway project. It was at this point that the local citizens, through the McHenry Avenue Improvement Association, offered to donate the land for widening the highway if the city would pay for disturbed improvements and if the State would construct the storm drain.

As a result, a formal co-operative agreement was executed in July 1957, which provided that the city would (1) acquire and convey to the State the rights-of-way necessary for the highway widening project; (2) complete the design of, and furnish construction plans and specifications for, the storm drain system; and (3) provide for the continuous operation and maintenance of the storm drain system after completion. The State agreed to construct the storm drain system and four-lane street section.

The magnitude of the right-of-way acquisition problem, for the City of Modesto, is indicated by the fact that 144 parcels were involved, many of which had buildings or other improvements to be relocated. The assistance rendered by the McHenry Avenue Improvement Association is gauged by the fact that all of these 144 parcels were settled amicably. Payment was made by the city for improvements only. No payment was made for land. The contract was awarded to McGuire and Hester, of Oakland, in May 1959 and the project, under the supervision of General Superintendent C. Aldrich, was completed in February 1960.

When construction started, a pamphlet, which outlined not only the work to be done but the order of work, together with a small project map, was furnished to all adjacent property owners. During construction, numerous newspaper articles plus daily newscasts from a local radio station assisted in keeping the public informed and expediting traffic through the construction area. These actions, plus excellent co-operation from the utility companies and a contract specification which limited the length of open storm drain trench to 100 feet, helped to create a very favorable relationship with the traveling public and adjacent land owners.



THEN—McHenry Avenue, looking south toward the Orangeburg intersection, November 1959.

Mixer Tests

Uniformity of Concrete Mixed Under Varying Conditions Studied

By BAILEY TREMPER, Supervising Materials and Research Engineer

THE MATERIALS and Research Department has completed tests of the uniformity of concrete mixed in a 34 E dual-drum paving mixer operating under variable conditions of batch size and time. The U.S. Bureau of Public Roads co-operated in financing and furnishing test data.

The tests were requested by Mr. Harold Allen, Chief, Division of Physical Tests, Bureau of Public Roads. Mr. Allen said that the states have widely different requirements for time of mixing and maximum size of batch in concrete paving mixers and that specification limits should be based on factual data of measured performance of mixers and that if such data were available better reconciliation between the requirements of the states should be possible. He requested that as many states as possible perform tests. It was realized that tests of a single mixer made at one time would not provide answers of universal application. However, a group of tests made in a number of states might provide information on which realistic decisions could be made.

Test Selected Batches

In compliance with Mr. Allen's request, provisions were made for mixing concrete in batches of 34.0, 37.4 and 40.8 cubic feet, each mixed for 30, 50 and 70 seconds. 100 batches of each of the nine combinations were to be mixed in succession and samples from the first and last portions of selected batches as discharged were to be furnished to the State for testing purposes. Special provisions for such work were included in a project, III-Pla-17-A,Roc,B. This project is on US 40 (Interstate Route 80), between Roseville and Newcastle in Placer County. Contract 59-3TC17-FIPD involving this work was awarded to A. Teichert & Sons.

Preparation for the tests were made soon after award of the contract. In order to secure samples directly from

... Continued on page 71



A crew carries on tests to determine the percentage of air in mixtures of concrete. Note the series of wash buckets in the foreground.



The general arrangement of the test area showing the dual facilities for two wash crews.

Sand Hill Road

San Mateo County Completes 2.9-mile FAS Highway Job

By ODO G. CAMEROTTO, Resident Engineer, San Mateo County

During 1958, the San Mateo County Board of Supervisors authorized the County Engineer and Road Commissioner to initiate a co-operative project with the State Division of Highways and the U.S. Bureau of Public Roads under the Federal-aid Secondary Highway Program for the improvement of Sand Hill Road.

A portion of this San Mateo County primary road is FAS Route 1004 and is the final link of road to be improved under the Federal-aid Secondary Program in the Alpine Road-Portola Road-Sand Hill Road loop which serves the more thickly populated areas of Woodside and the Portola Valley at the westerly end and the Cities of Menlo Park and Palo Alto at the easterly end. This project extended from Whiskey Hill Road, about one mile south of Woodside, to Santa Cruz Avenue, south of Menlo Park, a distance of 2.9 miles.

History

This road was first used in the 1850's to transport supplies and people to and from the historic town of Searsville, located just west of this project. Searsville was originally a gold rush town but because of the demand for timber, and its plentiful supply in the mountains nearby, turned to a lumbering town. Lumber wagons and stagecoaches used the road to get to Mayfield, now the area known as South Palo Alto, and Redwood City. During the wet winter months, Sand Hill Road, because of the nature of its underlying soil, was by far the best route to take to the Bayside communities. The other route to Redwood City, through Woodside, was frequently muddy and impassable.

Increased Traffic

The Leland Stanford Junior University, a primary landholder in this area, has recently started construction of homesites on its lands adjacent to Sand Hill Road. The historic Sharon property, one of the last remaining large estates on the Peninsula, is also in the process of being subdivided. It, too, adjoins Sand Hill Road at the easterly end of the project. The presence of these subdivisions has and will continue to increase traffic on Sand Hill Road. The two-lane highway at this location carries about 3,500 vehicles per weekday which increases to 5,000 vehicles per day on weekends due to recreational facilities at Searsville Lake.

Road Section Realigned

The project was designed as the initial stage of a future four-lane highway, the northerly two lanes being constructed at the present time. The future four-lane project will accommodate four traffic lanes 12 feet in width, with five-foot shoulders in cuts, and with eight-foot shoulders in fills, together with a 12-foot median strip dividing eastbound and westbound traffic.

Design and construction engineering for the project were provided at county expense and by personnel operating under the direction of Don S. Wilson, County Engineer and Road Commissioner. County personnel consisted of Odo G. Camerotto, Resident Engineer, Edward Bohlen, Office Engineer, and George Gaddy and Stanley Combs, Construction Inspectors.

About 640 eucalyptus trees, 5,600 shrubs and 53,000 ice plants will be used for landscaping on the San Francisco-Oakland Bay Bridge approach (US 40-50, Sign Route 17) between the Port of Oakland and the East Bay Distribution Structure.



A view of Sand Hill Road before reconstruction by San Mateo County.



A view of Sand Hill Road after reconstruction under the FAS program.

Talking About Highways—*Comments from the California Press*

These comments about highways appeared recently in California newspapers or were taken from other sources:

"We Cuss Them, But They Work"

Malcolm Epley in his "Beach Combing" column in the Long Beach *Press-Telegram* tells of several fast, long-distance freeway trips which he and acquaintances have made since the completion of the Ventura Freeway in the San Fernando Valley.

"I mention these experiences, not to prove that local people are fast drivers, but to remind that, section by section, the freeway builders are accomplishing what they set out to do.

"It takes time, and a lot of us get pretty impatient, but there finally comes a day when traffic takes off on another new and vital link in the dangest highway system on earth."

Epley reports that it is now possible to drive 120 miles from Ventura to San Juan Capistrano without encountering a traffic light.

"That indicates what has happened to facilitate traffic movement in an area that would have, without the freeways, the greatest jamups imaginable. We cuss the freeways, but they're working."

* * *

Good News in Humboldt

"More good news seems to emanate from the Highway Commission, via our local Division of Highways office, than you can figuratively 'shake a stick at.' We only wish all important news was half as good.

"Latest item was District Engineer Sam Helwer's announcement that funds for the Fortuna Freeway have been upped to $3 million, thus making it possible to finish that necessary job a year ahead of schedule. That was a real break.

"It wasn't long ago that many people hereabout were saying that they did not expect to see a freewayed route to San Francisco 'within our lifetime.' As matters are turning out, it is well they did not wager money on that prediction.'—Editorial in Humboldt *Standard*, Eureka.

* * *

New Era on Boulevard

With the opening of the Ventura Freeway, "a new era has dawned" along Ventura Boulevard, the former highway, according to an editorial in the Studio City *Graphic*.

"The eternal traffic congestion, long the merchants' nemesis, has been alleviated.

"Now's the time for boulevard businessmen to plan vital, promotional programs; to provide adequate parking; to begin thinking about beautification of their buildings and the boulevard in general. All these merchandising assets, hitherto discouraged because of the intolerable traffic, can now be cultivated."

* * *

Make Haste Slowly

The San Mateo *Times and News Leader* offered this editorial comment concerning a fatal accident on the Bayshore Freeway which occurred during a storm:

"If all of the drivers on the freeway had used common sense and slowed down their customary speed to a pace allowing full control of autos, despite the rain and gusty crosswinds, there would have been no fatality and no accidents.

"But a few careless drivers tried to drive through the storm at high speeds —ignoring the poor visibility and rain-slick condition of the roadway . . .

"The result was tragedy, the maiming of accident victims and heavy property damage. Thousands of man-hours of work were lost because a few tried to save a few minutes.

"Some loose-thinking people blame the freeway for this. But it is not the fault of the freeway.

"The fault lies with the careless and reckless drivers who abuse the use of the freeway and refuse to realize that it is subject to the need for due caution to be observed under adverse weather conditions. In this it is no different from any other thoroughfare.

"Under best of conditions the freeway is no safer than the drivers using it. And, unfortunately, a few bad drivers can endanger the lives of all good ones."

* * *

Consider Stomach Condition

George W. Savage in his San Bernardino *Sun Telegram* column commented on reminiscenses of E. Q. Sullivan, former district highway engineer, printed in "Profiles," publication of District VIII, Division of Highways.

"What interested us especially," Savage noted, "was his quote from a February 11, 1924, editorial which appeared in the San Bernardino *Sun:*

" 'It is to be hoped that we have heard the last knock aimed at the condition of the Old Trails Highway between this city and Needles, so long as it is maintained in its present condition. When it is possible for motorists to cover the 248 miles from the Colorado River town to this city in seven hours, or a maintained speed of 35 miles per hour for the entire distance, it might indicate that the driver who complains about the condition of the road ought to consider the condition of his stomach. It is not the highway that is bothering him.' "

"Just image the cases of dyspepsia there would be today," Savage added, "if motorists had to travel this busy route at only 35 miles an hour."

Construction will begin soon on the $20 million, 6,010-foot bridge over the main channel of Los Angeles Harbor. It will be Southern California's first toll bridge and financed by Toll Bridge Authority bonds, state highway funds, and highway user tax funds.

The California Highway Commission has adopted a freeway routing relocating portions of State Highway Route 87 (Oroville-Chico Road) in Butte County between Wick's Corner and U.S. Highway 99E.

Urban Planning

Highway Officials at AASHO-AMA Seminar

STATE and federal highway officials took part in a seminar on "Urban Planning and Its Relation to General Urban Development" April 11-13 at the University of California, Berkeley.

The seminar was the first of a series planned for various sections of the United States by the American Association of State Highway Officials, through its special committee on Urban Planning Seminars. Rex M. Whitton, chief engineer of the Missouri State Highway Commission, is chairman of the special committee.

At Berkeley, the arrangements were made by the university's Institute of Transportation and Traffic Engineering, including not only campus facilities but also the obtaining of some of the outstanding experts who conducted the sessions.

Generol Plan Needed

Highlights of the seminar included discussions led by T. J. Kent, Jr., Professor of City Planning, University of California. Kent pointed up the need for a general plan, defined the technical elements of the plan, described the legislative function of the plan and concluded with an analysis of the weaknesses in the present planning practice.

"One of our major weaknesses," said Kent, "is our inexperience at the job of building new cities and expanding and reorganizing old cities. In California our efforts to understand and dominate the powerful forces that are radically changing our cities and regional landscape are only 10 to 15 years old. I also feel quite certain that the constructive hard-driving postwar program of the California State Division of Highways to provide freeways in and around the cities of the State will be seen, in retrospect, as one of the major explanations for the establishment of effective local planning programs and the preparation and use of general plans by our city and county governments during the decades of the 1950's and 1960's."

"The Spatial Form of the City," presented by M. M. Webber, Associate Professor of City Planning, gave insight on how transportation and land use aspects of the master plan are integrated with all aspects of a city's development so as to assure attainment of the fundamental goals of a city.

Factors in Use Pattern

Paul F. Wendt, Professor of Finance and Director, Real Estate Research Program, University of California, emphasized that "as cities grow with the expansion of their economic base, they tend to develop a rational pattern of land use based on competition of uses." However, Professor Wendt pointed out that basic land use patterns may be modified by transportation routes which improve access of land, as well as by irrational property development and by specific physical conditions.

A promising technique as to how to evaluate the impact of improved transportation services, extension of sewer and water systems, available land for development, tax rates, etc., on land use development was demonstrated by Alan M. Voorhees, Traffic Planning Engineer, Automotive Safety Foundation. Such evaluation of land use development can be an effective basis for traffic forecasts and delineation of highway transport systems.

Richard M. Zettel, Research Economist and Lecturer, Institute of Transportation and Traffic Engineering, discussed the complex facets of highway finance in relation to the urban transportation system.

Co-ordination Keynote

The main theme of the seminar was summarized by John T. Howard, head, Department of City and Regional Planning, Massachusetts Institute of Technology.

"The future livability and prosperity of our cities," Howard said, "will be largely measured by our success in co-ordinating the careful design and control of our urban land uses with the careful design and construction of our circulation systems, highways and transit.

"To win this success, we need to exploit the growing movement toward co-ordination among the number of governmental agencies and levels that are concerned with land use and with highways, and also the better professional understanding that is developing between highway engineers and city planners."

Harmer E. Davis, professor of civil engineering and director, Institute of Transportation and Traffic Engineering, moderated the three-day session.

Participants included highway officials from eight western states, and representatives of the U.S. Bureau of Public Roads, the American Municipal Association, AASHO, and the Joint AASHO-AMA Committee.

California representatives in attendance included State Director of Public Works Robert B. Bradford, Deputy Director Harry D. Freeman, State Highway Engineer J. C. Womack, and nine other high-ranking officials of the Division of Highways.

FEDERAL-AID CONTRACTS

A total of 6,743 federal-aid highway construction contracts was awarded through the various state highway departments during 1959, involving a total cost of approximately $2.5 billion, according to the Bureau of Public Roads, United States Department of Commerce.

The contracts awarded in 1959 had an average cost of about $370,000. They varied in size from less than $25,000 to about $8,000,000, with an equitable distribution throughout the entire range. Twenty-nine percent of the federal-aid highway construction contracts awarded by the state highway departments were for amounts less than $50,000. Another 17 percent of all contracts were for amounts between $50,000 and $100,000, and 23 percent were between $100,000 and $250,000.

Martin A. O'Brien Retires on May 1

Martin Anson O'Brien, Highway Signing Supervisor, retired May 1 after 26 years of service with the California Division of Highways.

A native Californian, O'Brien was born in San Francisco, studied civil engineering at St. Mary's College in Oakland and graduated from the University of California at Berkeley with a degree in mining. His first job after graduation was with the Black Oak Mine in Soulsbyville where he worked as a solution man in the cyanide mill.


MARTIN A. O'BRIEN

In August 1917 he joined the Army and during his two-year hitch he saw much of Europe and was selected to attend the University of London where he studied law and geology until sent back to the states for discharge. He worked for the U.S. Shipping Board as an assistant purchasing agent for several years and was later affiliated with a number of the major oil companies in California in various engineering capacities.

O'Brien was appointed senior clerk for the transportation survey of the State of California in 1934 and has worked for the Division of Highways in the Maintenance Department since that date. He was editor of the 1949 Highway Maintenance Manual and editor and author of the 1958 manual. As Highway Signing Supervisor O'Brien has played a major part in the development of California signing practices. He also worked closely with interested agencies and groups on the placement of historical landmark roadside markers throughout the State.

Mrs. O'Brien (the former Gertrude Greene) is also a native Californian, as are the three O'Brien children, Mrs. Dorothy J. Wilkins, John A. O'Brien, and Mrs. Jean C. Lindsey. The O'Briens celebrated their 40th wedding anniversary two days before he retired from state service.

'Tempus Fugit' Corner

Twenty-five years ago. The following items appeared in the May and June 1935 issues of *California Highways and Public Works.*

US 99 Relocation

Construction of the proposed Kennett (Shasta) Dam will necessitate the rebuilding of some 16 miles of State Highway Route 3 (US 99) in Shasta County and approximately 37 miles of the Southern Pacific Railway.

Preliminary surveys for the relocation of both highway and railroad began in February of this year, and fieldwork on both surveys was practically complete by June 1. Plans and estimates are in progress.

Beauty Award Winner . . .

. . . in a bridge contest and not a card game, is the new state-designed "Smith Point" Bridge on the Redwood Highway where it crosses the South Fork of the Eel River just south of Garberville.

It is the first continuous steel girder bridge built on a curve in America and was awarded honorable mention in a national competition for the most beautiful steel bridge built last year.

Emergency Measure

Protests against federal taxation of gasoline were filed with members of Congress by more than 250 organizations representing millions of citizen taxpayers, and 21 states adopted memorials asking that the tax be ended June 30, 1935.

The gasoline tax, it was pointed out, was enacted in 1932 as a temporary emergency measure and was re-enacted in 1933 and again in 1934.

Ramona Boulevard Planting

The first comprehensive state highway landscaping project was started on Ramona Boulevard from Los Angeles civic center to Garvey Avenue.

About 8,000 trees and shrubs and 25,000 ground cover plants were placed under this first state landscaping contract on record, for which $30,000 in federal aid money was allotted.

Eureka Engineer Retires on June 30

Charles P. Sweet, Assistant District Engineer, Operations, District I, in Eureka, will retire on June 30, 1960, after 38 years with the California Division of Highways. A native Californian, he was educated in Ferndale schools and at Healds School of Engineering in San Francisco. Except for a three-year period spent as assistant city engineer for the City of Santa Barbara (1927 - 1930) Mr. Sweet has been employed by the State of California since April 1919 in some phase of engineering.


CHARLES P. SWEET

Starting work in Eureka as a surveyor on highway construction projects he advanced to the position of assistant resident engineer on construction projects and resident engineer on the early work done by honor camp forces from state prisons in the Redwood Creek area in Humboldt County. In 1925 he was transferred to the San Luis Obispo district where, in addition to supervision of road and bridge construction projects, he also worked on special studies in connection with the State Materials and Research Laboratory of Sacramento. (Among these special studies was a test of the degree of compaction obtainable with the first sheepsfoot roller used in compacting highway embankments in California.)

After his employment with the City of Santa Barbara he returned to Eureka where he advanced from resident engineer on highway construction projects to district office engineer. In 1935 he was appointed district construction engineer. He was promoted to assistant district engineer, operations, in 1951.

Sweet has two sons, Charles, Jr., (Resident Engineer in District IV) and Raymond (City and County Cooperative Engineer, District I in Eureka). He also has a daughter, Mrs. Francis Walker of Ferndale.

Division Announces Recent Retirements

Headquarters Office

F. W. Panhorst, Assistant State Highway Engineer, 32 years

Edward L. Schreiber, Junior Research Technician, 11 years

District I

Bernard J. Burgess, Highway Equipment Operator-Laborer, 29 years

Harold E. Eyles, Highway Field Office Assistant, 24 years

District II

Loran Risley, Skilled Laborer, 20 years

District III

Arthur S. Haskell, Highway Leadingman, 27 years

District IV

Fred H. Leighton, Highway Leadingman, 25 years

District V

Millard A. Dawson, Assistant Highway Engineer, 30 years

District VII

Alex G. Black, Assistant Highway Engineer, 30 years

William L. Jump, Carpenter I, 26 years

Ray W. Lawson, Groundsman, 4 years

District IX

H. V. Haskett, Highway Equipment Operator-Laborer, 22 years

District X

Clayton P. David, Drawbridge Operator, 26 years

Ted McClurg, Highway Equipment Operator-Laborer, 31 years

District XI

David S. Julien, Storekeeper I, 11 years

Horace V. Lerwill, Window Cleaner, 5 years

Eugene Sorin, Associate Highway Engineer, 33 years

Bridge Department

John W. Green, Supervising Bridge Engineer, 30 years

Materials and Research Department

John E. Borchert, Assistant Physical Testing Engineer, 23 years

Margaret F. Callaway,* Intermediate Stenographer-Clerk, 10 years

Shop 2

Edmund K. Miller, Skilled Laborer, 28 years

* Disability retirement.

Shop 3

Janice H. Wald, Accounting Technician III, 27 years

During the past fiscal year, Division of Highways installed 19,464 new signs along state highways.

Grove-Shafter Freeway Project Provides For Possible Future Rapid Transit System

The State Division of Highways has found a way to provide for possible rapid transit lines in connection with the Grove-Shafter Freeway in Oakland without delaying current and budgeted construction on the MacArthur Freeway, it has been announced by State Director of Public Works Robert B. Bradford.

Subject to an agreement with the San Francisco Bay Area Rapid Transit District covering the additional costs involved, Bradford said, the State is willing to defer some structural work originally planned for the interchange area of the two freeways near Telegraph Avenue. This structure work was to have been included as part of a MacArthur Freeway construction project soon to be advertised for bids.

The rapid transit district has proposed that its planned Oakland-Richmond and Oakland-Concord transit lines be located within the dividing strip between the two roadways of the Grove-Shafter Freeway.

"Consistent with our policy of maximum co-operation with other agencies to solve overall transportation problems," Bradford said, "the State's engineers have arrived at a solution to the problems of proceeding on schedule with the urgently needed MacArthur Freeway without precluding future rapid transit plans on the Grove-Shafter."

Bradford said General Manager John M. Peirce of the rapid transit district was being informed of the State's readiness to work out a mutually satisfactory agreement. He was reiterating in his letter to Peirce, he said, "the fact that the Department of Public Works is vitally interested in the overall transportation needs of the State," including rapid transit as well as highways, and especially the 8 a.m. and 5 p.m. commuter peak hour problem.

He explained that the Division of Highways had planned to build some structure foundations and supports for the Grove-Shafter Freeway as part of a budgeted project on the MacArthur Freeway, in the vicinity of Telegraph Avenue and West Street near 35th Street in Oakland. This job is scheduled to be advertised for bids in April.

By completing certain structural work on the Grove-Shafter Freeway early, Bradford said, the remaining work on the interchange could be done later without disrupting traffic on the MacArthur Freeway, which would then be in operation. However, in order to make the proposed rapid transit plan possible, he said, the State was agreeing to defer most of this advance structural work. There would be no appreciable delay in construction of the MacArthur Freeway, he emphasized.

In his letter to Peirce, Bradford said the State would approve the location of transit lines in the Grove-Shafter center strip "provided that the rapid transit district bears all the added construction and right-of-way cost by reason of such location, and that such plan does not delay construction of the Grove-Shafter Freeway.

A firm agreement between the rapid transit district and the State should be reached by July 1, 1961, he said, in order to meet Division of Highways schedules for right-of-way acquisition and construction.

The rapid transit district is planning to finance construction of a transit system in the San Francisco Bay area through the issuance of general obligation bonds. A bond election is expected to be held in the fall of 1960 or the spring of 1961.

Scenic Coast Route Urged by Committee

In a report to Governor Edmund G. Brown, the Standing Committee on Public Works and Natural Resources of the Governor's Council has proposed a "Pacific International Scenic Drive" extending through the coastal scenic areas of California, Oregon and Washington from Mexico to Canada.

The committee recommended that Governor Brown confer with the governors of Oregon and Washington and seek the co-operation of those states in preparing separate but concurrent and co-ordinated studies and plans for their portions of the route.

The report states that "The natural character of the coastal area of California is such that a scenic route through the area would be a priceless asset in fostering the preservation and public use of world-renowned scenic areas, recreation areas, sites of historical value and in promoting the economic welfare of the area traversed and the State of California as a whole."

The proposed route would compare as a pleasure route with the Blue Ridge, Appalachian and Great Smoky Routes and the Mississippi Route established in other parts of the country.

The report recommended:

"All new or existing highways comprising the scenic route should be located and designed to preserve the natural landscape through rural areas, which may be accomplished by acquisition of suitable land, beyond right-of-way needs, or by scenic easements through appropriate state agencies. For urban areas the route should be appropriately designed for a high order of utility, safety and aesthetic quality. The terms 'utility, safety and beauty', as applied to the Mississippi Valley Parkway, should govern the design and construction of the entire route."

Director of Public Works Robert B. Bradford said the route would provide motorists with an "unparalleled and changing panorama of beauty." He said that "not only are there many miles of beautiful scenery that can be viewed from this highway itself, but it will also provide easy access to numerous scenic and recreational areas."

Bradford noted that 95 percent, or 985 miles, of the route in California is in the state highway system and will, in the normal course of events, be improved to adequate standards with state highway funds. He estimated the cost of bringing these highways up to proper standards at a little over $900,000,000 which he said could be accomplished in approximately 20 years under the present financing structure.

The route in California would be about 1,030 miles in length.

During the past fiscal year the Division of Highways approved requests for a total of 27,270 signs, consisting of 5,774 warning signs, 7,198 regulatory signs, 11,762 guide signs and 2,536 construction and other miscellaneous signs.

TWENTY-FIVE-YEAR AWARDS

Employees who have received 25-year awards since those listed in the January-February edition of *California Highways and Public Works*

DIVISION OF HIGHWAYS

Headquarters Office
Horace H. Bosworth
Kenneth A. Keyes
Ann Tucker
Clifford J. Tyack
Paul I. Wagner

District II
Victor Lammers
Henry H. Pickrell

District III
David W. Roberts
Clifford H. Willett

District IV
Leon W. Couch
George R. Weymouth

District V
Henry C. Anderson
Clarence E. Blinn

District VI
U. H. Erickson

District VII
James B. Griffin
Chester N. Wilczek

District VIII
Seth P. Alexander
Herman B. Crass
Bernice Updyke

District X
Robert E. Brown

District XI
Don C. Smith

State-owned Toll Bridges
John R. Doran
Cecil West

Headquarters Shop
Edward H. Higginson
Frank T. Myers

Shop 4
Arthur M. Gehl

Cost Index Down for First Quarter of 1960

During the first quarter of 1960 the California Highway Construction Cost Index continued its downward course. The index now stands at 219.8, a drop of 9.3 points or 4.1 percent from the fourth quarter of 1959, which is a lower rate of decrease than the 12 percent drop which occurred in the fourth quarter of 1959.

Despite continued pressure of wage increases and rising costs of materials and equipment in the construction industry, it appears that highway projects in California advertised for bids in the second quarter may continue to be built at lower cost to the State. Apparently this is due to keen competition (an average of 10.5 bidders per project for the 12 multimillion-dollar freeway projects opened in the first quarter).

Belts Favored For Drivers, Passengers

State, county and city officials in charge of the operation of motor vehicles almost without exception favor the use of seat belts by drivers and passengers, according to a recent article in the Los Angeles *Herald-Express* by feature writer Charles Page.

Page reported that "an untold number of lives and injuries are being saved by the use of automobile seat safety belts in public-owned vehicles, and greater use of the device is being urged by public officials on the basis of this experience.

Seat belts are not new in public vehicles, Page reported. In 1955 belts were installed on state-owned vehicles, and virtually all emergency vehicles in Los Angeles City and County are equipped with belts.

The article refers to statements by State Director of Public Works Robert B. Bradford in a letter to division heads.

Bradford's letter emphasized that the use of seat belts is mandatory in the Department of Public Works, and pointed out that two state employees killed in recent accidents "might still be alive had they used seat belts."

Los Angeles police officers are sold on the use of belts, Page wrote, particularly if they are on patrol duty where emergency runs are routine.

He cited the case of two officers who "are confident they were spared death only because of their safety belts."

The two men escaped with concussions when their vehicle was involved in a collision "with an impact so great that the siren, fastened on a front fender, ended in the seat after the impact and the two rolls taken by the car."

A veteran accident investigator for the Los Angeles Police Department told Page of an accident resulting when a car skidded on slippery streets.

"The driver, whose seat belt was fastened, received a stomach jolt, but his passenger, ignoring the belt, was thrown from the car and received a fractured skull."

Page reported that there are so many other cases, that officials say they can be certain installation and use of belts pays off in lives saved.

R-SR Bridge Users Will Get Pamphlet

Tourists using the Richmond-San Rafael Bridge will soon receive an informative pamphlet answering many of the questions asked about the bridge by those crossing it since its completion in 1956.

The pamphlet, which will be available on request at the toll stations, includes a map of the area served, a brief description of the other bridges forming the "steel triangle," and a more detailed description of the Richmond-San Rafael Bridge including current toll costs for various vehicles.

The map shows how the three bay bridges—the Golden Gate, San Francisco-Oakland, and the Richmond-San Rafael—form the scenic "steel triangle" spanning San Francisco Bay. It also shows how the Richmond-San Rafael Bridge provides access from the interior valley and East Bay cities to the rich recreational areas of the northern California coastal counties.

Another section of the pamphlet contains information as to the length, cost, and capacity as well as the type of span construction of the bridge. Toll schedules for various vehicles from motorcycles to three-axle buses are contained in the pamphlet. A special section is devoted to telling the driver what to do in case of an emergency while on the Richmond-San Rafael Bridge.

Contractor's Letter Asks Co-operation

Personal letters to the public notifying them of the beginning of work on seven and one-half miles of freeway construction on U.S. Highway 91 were received in Corona recently from the contracting firm of Fredericksen and Kasler in an effort to gain community interest and understanding.

The letter indicated that it was to the financial best interest of the individual taxpayer and property owner to have the work completed as quickly and economically as possible. To accomplish this it was necessary to use heavy construction equipment. "We realize, of course," said the letter, "that the presence of construction equipment in any neighborhood is welcomed only by citizens under the age of six. For the rest of us, it's something of an inconvenience—but it is only temporary."

Fredericksen and Kasler state that they will be glad to co-operate with the community in meeting problems in dirt moving, dust, traffic, safety and noise. Their equipment operators are trained to take every precaution, but, they warn, "parents are cautioned that equipment holds great fascination for our mechanically minded younger set."

National Convention For ASCE Planned

Many employees of the Division of Highways who are members of the American Society of Civil Engineers will attend the national convention of the organization which will be held in Reno June 20-24.

The Sacramento section of ASCE and its Nevada branch are cohosts for the convention. General chairmen for the meeting are R. Robinson Rowe, Sacramento, principal bridge engineer of the Division of Highways and former national director for District XI, and Dean Howard B. Blodgett of the University of Nevada. Stewart Mitchell of Sacramento, retired Division of Highways bridge engineer, is program chairman.

More than 100 papers, sponsored by 11 of the society's technical divisions, will be presented during the five-day meeting. Several of the papers to be presented are concerned with the conversion of sea water for domestic, agricultural and industrial purposes, and the problems involved in utilization of land with a saline content.

Highway programs, particularly in the mountain areas, will be under study with the ASCE highway division conducting two sessions, and holding joint sessions with the construction division and the surveying and mapping division. The highway program includes three panel discussions.

Tours and programs are being planned for the ladies.

R-SR Bridge Marks 10,000,000th User

The ten millionth driver to cross the Richmond-San Rafael Bridge turned out to be truck driver Dean Hoagland of Fresno, and his vehicle was a truck and trailer operated by Kings County Truck Lines of Tulare and carrying canned evaporated milk.

Hoagland was a surprised driver as as he pulled into the westbound toll lane just before 4 p.m. on Sunday, March 27, and was asked to wait for a moment after paying the $3 toll for the five-axle refrigerated combination.



The ten millionth driver to cross the Richmond-San Rafael Bridge since it opened in September 1956, was truck driver Dean Hoagland of Fresno (left). Hoagland, whose five-axle combination was hauling refrigerated canned milk from Chowchilla to Eureka, is shown receiving a letter from Governor Edmund G. Brown, delivered by Assistant State Director of Public Works T. Fred Bagshaw (right).

He was greeted by a group of state officials and newspaper photographers and was handed a letter from Governor Edmund G. Brown calling attention to the "10,000,000" milestone in the history of the 3½-year-old bridge providing a direct overwater link between the Redwood Empire area and the East Bay and Central Valley regions.

Representing the Governor at the brief ceremony was Assistant Director of Public Works T. Fred Bagshaw. Others present included Norman C. Raab, chief of the State Division of San Francisco Bay Toll Crossings, who supervised construction of the bridge; Bridge Manager A. P. Simatovich; and Toll Lieutenant R. A. Schimmel.

H. Ray Judah

Former State Senator H. Ray Judah, 78, died on May 5 in his home city of Santa Cruz after a short illness.

Mr. Judah served as a member of the California Highway Commission from May 1936 to March 1939, including more than a year as its chairman.

A native of Menlo Park, he was a grandnephew of Theodore D. Judah, chief engineer of the Central Pacific Railroad in the 1860's. He was a cofounder of the Santa Cruz *News* in 1907, and remained as its publisher until it merged with the *Sentinel* in 1938. He also served as manager of the Santa Cruz Civic Auditorium and as chamber of commerce manager. He retired in 1959 as auditorium manager.

He was one of the organizers of the California Newspaper Publishers Association and was its president for two years in the late 1920's.

Mr. Judah was elected to the State Senate from Santa Cruz and San Benito Counties in 1940 and served until he decided not to run again in 1952.

He is survived by his wife, Eva Bowman Judah; two daughters, Mrs. Barbara Sprague of Santa Cruz and Mrs. Janice Futch of Hayward; and a brother, Floyd Judah of San Francisco.

County Vehicle Fees Total $115 Million

County shares in $115 million of motor vehicle license revenues will be smaller during the 1960-61 fiscal year for 38 of California's 58 counties due to the 1960 federal census, according to State Controller Alan Cranston.

Distribution of the revenue is based on population figures contained in the most recent federal census. The revenue, which is in lieu of a local property tax on vehicles, is collected by the State with approximately 50 percent being returned to the cities and 50 percent to the counties.

Since the federal census is taken only once every 10 years, the population figures used in allocating these funds may not reflect actual population changes, especially during the final years of the old census period. This often means that there will be a wide disparity between the allocations for the last year of the old census period and the first year of the new one.

Estimated apportionments for cities will not show such great fluctuations since population figures are adjusted regularly to encompass special censuses, annexations and incorporations.

Bridge Design Manual Now Available at SPO

The Bridge Department of the California Division of Highways announced publication this month of its "Manual of Bridge Design Practice" for sale to interested individuals in the U.S. and abroad.

The publication grew out of the large number of requests for the information since it first appeared in multilith form in 1952 as in-service training material. The manual has been revised several times since then and is believed to be the only published work containing complete and practical procedures for the design of the usual types of bridges.

The 14 sections of the manual cover such subjects as Bridge Economy, Review of Moment Distribution, Bridge Loadings, Slab Bridges (longitudinally reinforced), Design of T-Beam Highway Bridges, Design of Box Girder Highway Bridges, Simple Span Rolled Beam Bridges, Design of a Welded Girder Highway Bridge, Simple Span Composite Girder Bridge, Design of a Deck Girder Railroad Bridge, Design of Through Girder Railroad Bridge, Simple Span Deck Truss Bridge, Theory of Prestressed Concrete, and Design of a Prestressed Concrete Girder.

The "Manual of Bridge Design Practice" can be obtained from the State of California, Printing Division, Documents Section, North 7th Street and Richards Boulevard, Sacramento 14, California. Postpaid prices per copy are: $12.50 (within U.S. excepting California), $13 in California (includes sales tax), $13.50 outside continental U.S.

GEODIMETER

Continued from page 16 . . .

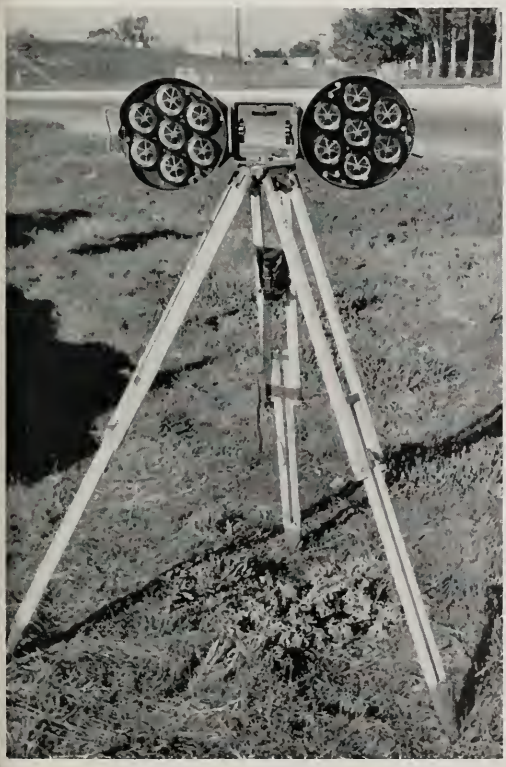
The purpose of this triangulation net was to provide primary control upon which subsequent lower order nets could be based. These secondary nets were to control photogrammetric mapping and location of a transmountain highway, which was to follow the East Fork of the San Gabriel River. The Llano Base Line was established to provide a much-needed extension of the geodetic Control System of Los Angeles County into the Antelope Valley.

Difficult Terrain

This county triangulation project involved field observations in exceedingly rough terrain, the occupation of stations up to 9,000 feet in elevation, and many grueling climbs for the



To the left is the master unit ready for observations and measurements. To the right is the theodolite to measure the horizontal angles between stations being observed.



The double reflector slave unit used for measuring long lines.



District survey personnel with the single reflector slave unit used for measuring short lines.

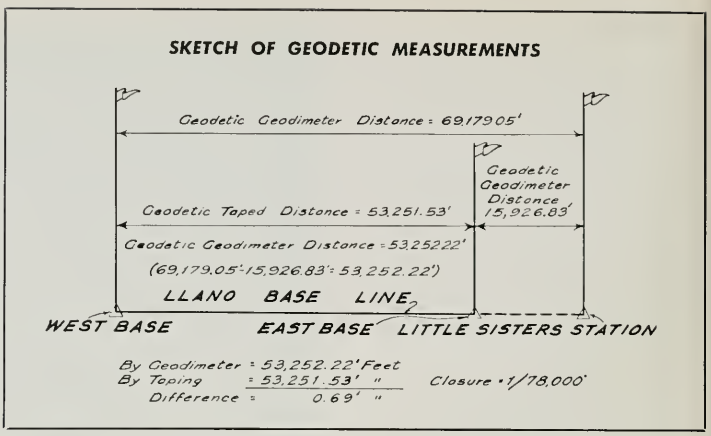
county field personnel. All angle turning was performed at night with a directional theodolite reading to 1/10 of a second, sighting on lights at the distant points. To help strengthen the geometric configuration defined by the points used, a base line approximately 10 miles in length was laid out by county forces along the Antelope Valley floor from station Little Rock H-11 (Llano West Base) to station Black Butte E-9 (Llano East Base). The actual taping of the Llano Base Line was done by an eight-man party over the period of September 2 to 15, 1954. All procedures and standards of first order geodetic taping were used. Briefly, this involved using 50-meter invar tapes which had been calibrated previously by the National Bureau of Standards, and applying the necessary corrections for calibration, temperature, sag, alignment, tension and slope. The last item required spirit leveling over the chaining bucks to determine the actual difference in elevation for each tape length.

The reduced taped length gave a result of 53,259.24 feet as the geodetic length at ground elevation with a probable error of ± .021 foot, or 1 part in 2,564,000. Finally, this distance between end stations was reduced to sea level giving a geodetic distance of 53,251.53 feet. This latter amount was used in the subsequent least squares adjustment of the entire triangulation net. It is interesting to note the Llano Base Line had a preliminary closure of 1 part in 100,000 with a fixed line in the southerly portion of the net some 20 miles away.

All the geodetic work in the establishment of the Llano Base Line was performed by the Los Angeles County Engineer Department under the direction of E. T. Mankey, Division Engineer of their Survey Division, before the State Division of Highways entered the picture.

Base Line Gives Control

The District Survey Department decided to use the Llano Base Line because it was the latest first order base line available in the area and would give the district the needed control to check into, evaluate and adjust our triangulation nets. The use of this base line provides a perimeter of control for our co-ordinate maps covering a large part of the district's area of operations. It gives first order precision at a very low cost.



The state personnel of the geodimeter crew consisted of two men from headquarters and augmented by four men from the district's survey department. The headquarters men were trained geodimeter operators or instrumentmen and the district men did the work of light tending of the slave unit, and measurings of horizontal and vertical angles.

The geodimeter measurement of the Llano Base Line required three nights due to inclement weather. This could have been accomplished in one night, weather permitting. The district crew turned the horizontal and vertical angles used in the triangulation system after the geodimeter crew had finished their distance measurements.

A direct measurement between the West Base, Station Little Rock H-11, and the East Base, Station Black Butte E-9, could not be done. Intervisibility was not possible, without the use of towers, along the base line. The measurement by the geodimeter was accomplished by measuring two segments as illustrated in the accompanying sketch. Both segments were measured from one station, called "Little Sisters," a point set on line at an elevation so that the Llano Base Line would be seen in its entirety.

The difference in the distance from Little Sisters to West Base and Little Sisters to East Base gave the required base line measurement.

Data Are Processed

All field data and measurements were submitted to Sacramento Headquarters and processed through the electronic computer section. The results were returned to the District Survey Office within a week. The processed data was in turn incorporated into the district's co-ordinate control maps.

The geodimeter measurement by state forces of the Llano Base Line gave a closure of 1/78,000. This closure is of a precision suitable for all purposes of the district's use and is highly acceptable.

This district has used the geodimeter in measurements of other lines that have not been so rigidly controlled and we now have full confidence in the exactitude of those previous measurements. The same procedures were employed on the other lines as were employed on the Llano Base Line. The use of the geodimeter is a most satisfactory method for measuring lines of great length, in establishing triangulation nets and for measuring ties to other controls for our co-ordinate maps.

The economic benefits of utilizing the geodimeter over conventional survey crews in taping long lines and triangulation systems are self-evident.

MIXER TESTS

Continued from page 60 . . .

the mixer drum during discharge, the contractor cut a hole in the side of the discharge bucket at the top and installed an inclined swivel chute which could be swung in and out of the discharge stream from the mixer as the bucket was being filled. Samples of concrete during discharge of the first and last quarters of the batch were collected in wheelbarrows which the contractor delivered to pans on the opposite side of the roadway.

100-Batch Combinations

Testing of the samples was performed by personnel of the Materials and Research Department. From each group of 100 batches of each combination of size and mixing time either three or four batches were selected for sampling and testing. Each batch was timed accurately with a stopwatch by personnel of the Bureau of Public Roads.

The tests performed on each portion of each sampled batch were slump, air content, unit weight of air-free mortar, weight of coarse aggregate per cubic foot of concrete, compressive strength and cement content. Comparison of these test properties between the two portions of the batch provided data for evaluating the uniformity with which the ingredients were distributed throughout the batch. In addition to these results, a comparison of all compressive strength results for each combination of batch size and mixing time provided data for measuring the effects on the quality of the concrete produced under these conditions.

The required number of 900 batches was mixed during two days of operation: July 25 and 26, 1959. The work of mixing, sampling and testing proceeded smoothly due to careful preparation on the part of the contractor and laboratory and to trial runs previous to the test dates.

New Mixer Used

The mixer used by the contractor was relatively new and most of the original blades had been replaced with new ones prior to starting work on this contract. The results obtained were, therefore, applicable to mixers of a particular make in good condition.

According to criteria established for performance, all of the tested batches except one were mixed to an acceptable degree of uniformity. The unacceptable batch was the last one discharged prior to the noon shutdown. At this time the first drum of the mixer presumably was empty. It is reasoned that the transfer chute was not closed and that remnants from the first drum dribbled into the second drum and did not become thoroughly intermingled before discharge. While this may be an isolated example of abnormal operation, the possibility of its occurrence is present twice each day when shutdowns are made at noon and night, and at other times if there are prolonged delays in paving operations.

Although, with one exception, satisfactory intermingling of the constituents was accomplished under all operating conditions with this particular mixer, the trends were examined with a view to the possibility that unsatisfactory mixtures might be produced in other mixers that might be in poorer condition or that might be inherently less efficient. The data point to the following tentative conclusions:

For 34 E paving mixers in good condition, mixing times as short as 30 seconds appear to produce acceptable intermingling of the constituents.

Condition Important

For 34 E paving mixers, batches of 40.8 cubic feet (20 percent overload) may not be satisfactorily intermingled when mixed for periods up to 70 seconds, unless the mixer is in first-class condition.

Very careful planning and supervision on the part of the contractor were required in order to discharge batches of cement and aggregates into the skip of the mixer at a rate fast enough to perform the mixing consistently within a period of 30 seconds.

Apart from producing concrete in which the ingredients are uniformly distributed, the question remains as to the effect of mixing conditions on the quality of the resulting concrete. The compressive strength of the concrete is one measure of its quality. The test data indicate little or no effect of mixing time within the limits of the test program but they do point to a moderate loss in strength with increasing size of batch as shown in the following tabulation:

Size of batch cubic feet	*Relative compressive strength, average of all mixing times*
34.0	100
37.4	97
40.8	93

The test results of themselves do not have great significance except as to the performance of a particular mixer in a particular state of condition. When considered together with similar data provided by other states, it is probable that dependable conclusions leading to greater uniformity in specification requirements can be reached.

The contractor used two mixers operating in tandem. Batch sizes were varied simultaneously in both mixers, but mixing time was varied only in the mixer used for testing. It is not possible to distinguish between the products of the two mixers in the constructed pavement. The effect of the batch size on future performance of the pavement can be studied but no conclusions can be reached as to the effect of variations in mixing time.

Dredge, Fill Work For Bridge to Start

The State Department of Public Works has opened bids on the work of dredging and constructing fills in connection with widening of the San Mateo-Hayward Bridge.

The work calls for the dredging of an access channel adjacent to the west end of the bridge approximately 8,000 feet long and 100 feet wide to a minimum depth of 14 feet; and for the transporting of the dredged material to a designated fill area adjacent to the bridge approach road on Brewer Island.

Approximately $70,000 is available for the work.

Norman C. Raab, chief of the Division of San Francisco Bay Toll Crossings, said this will be the first major overwater contract on the $35,500,000 project to widen the two-lane San Mateo-Hayward Bridge to four lanes.

The access channel will be used for contractors' floating equipment for subsequent structural work.

EDMUND G. BROWN
Governor of California

CALIFORNIA HIGHWAY COMMISSION

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CHESTER H. WARLOW, Vice Chairman . Fresno
JAMES A. GUTHRIE San Bernardino
ROBERT E. McCLURE Santa Monica
ARTHUR T. LUDDY Sacramento
ROGER S. WOOLLEY San Diego
JOHN J. PURCHIO Hayward
JACK COOPER, Secretary Sacramento

DEPARTMENT OF PUBLIC WORKS

ROBERT B. BRADFORD Director
FRANK A. CHAMBERS Chief Deputy Director
RUSSELL J. COONEY . . Deputy Director (Management)
HARRY D. FREEMAN . . Deputy Director (Planning)
T. F. BAGSHAW Assistant Director
JOHN H. STANFORD Assistant Director
S. ALAN WHITE . . Departmental Personnel Officer

DIVISION OF HIGHWAYS

J. C. WOMACK
State Highway Engineer, Chief of Division
CHAS. E. WAITE . . . Deputy State Highway Engineer
J. P. MURPHY . . . Deputy State Highway Engineer
J. W. TRASK . . . Assistant State Highway Engineer
J. A. LEGARRA . . Assistant State Highway Engineer
LYMAN R. GILLIS . Assistant State Highway Engineer
J. E. McMAHON . . Assistant State Highway Engineer
E. R. HIGGINS Comptroller
FRANK E. BAXTER Maintenance Engineer
L. L. FUNK Planning Engineer
MILTON HARRIS Construction Engineer
F. N. HVEEM . . . Materials and Research Engineer
H. B. LA FORGE . Engineer of Federal Secondary Roads
GEO. LANGSNER Engineer of Design
SCOTT H. LATHROP . Personnel and Public Information
H. C. McCARTY Office Engineer
E. J. L. PETERSON . . Program and Budget Engineer
F. M. REYNOLDS Planning Survey Engineer
EARL E. SORENSON Equipment Engineer
G. M. WEBB Traffic Engineer
M. H. WEST . Engineer of City and Co-operative Projects
A. L. ELLIOTT Bridge Engineer—Planning
L. C. HOLLISTER . . . Projects Engineer—Carquinez
I. O. JAHLSTROM . . . Bridge Engineer—Operations
DALE DOWNING . . Bridge Engineer—Southern Area
R. R. ROWE . . . Bridge Engineer—Special Studies

Right-of-Way

FRANK C. BALFOUR . . . Chief Right-of-Way Agent
E. F. WAGNER . . . Deputy Chief Right-of-Way Agent
RUDOLF HESS Assistant Chief
R. S. J. PIANEZZI Assistant Chief
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District IV

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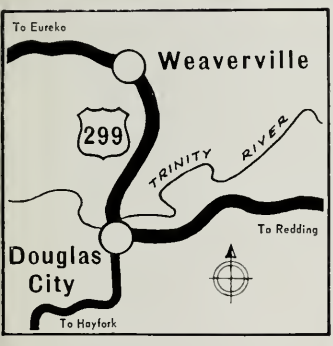
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1914



In the early days of the state highway system, when California was sporsely populated and there was a woeful shortage of funds for improvements, mountain roads got little attention. The one in the old photo above was good for its day. Mountain traffic was light, and mountain drivers were expected to be competent—those who weren't stayed out of the mountains.

Today's drivers want to range freely through the mountains, and routes such os this which give access to important recreational oreas must be well engineered for safety.

Both views are made at approximately the same spot, looking north toward the Trinity Alps from a spot slightly south of Weaverville. This route is now US 299. The portion from Redding to Weaverville wos token into the state highway system in 1909, the remainder of the route to Arcata and Eureka in 1915. A portion of an older alignment no longer in use is seen at lower right in the bottom photo.

1958



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Highways, Water and Planning

By ROBERT B. BRADFORD, Director of Public Works

From the very beginnings, California's system of major vehicular transportation arteries has been developed on the basis of sound long-range engineering planning on a statewide scale. This planning process has started with the Legislature, which has authorized the studies. It has continued with the work of eminently qualified engineers. And it has subsequently, after explanation, discussion and review, been translated by the Legislature into action.

The result has been a developing system of modern highways which has served as a model for many other states and which is generally conceded to be meeting the growing traffic needs of California with maximum efficiency and as rapidly as available funds permit.

The culmination of this planning process was the California Freeway and Expressway System established by the Legislature in 1959 after a two-year study. California has thus become the first state to undertake its major highway development in accordance with an integrated master plan looking 20 years ahead and providing for updating and revision as needed.

The philosophy that is working so well for our highway development should certainly be practical in dealing with another principal byproduct of California's fantastic population growth—the water problem.

The studies leading to the development of the California Water Plan were undertaken several years ago, while the State's water resources agency was still a division of the Department of Public Works. These studies have been characterized by the same combination of practical engineering analysis and bold imaginative foresight as our highway planning. They represent the consensus of the best available professional thinking as to how best to meet California's increasingly critical water needs.

But in the case of the California Water Plan the Legislature cannot carry the whole burden of official action. It is necessary to submit the plan to the people of the State as a whole, since a general obligation bond issue is involved. Incidentally, the amount of the bond issue may appear large from some points of view, but it amounts only to about three years' expenditure on the State Highway System.

There are other parallels between the water program and the highway program beyond the fact that failure to plan and execute either program effectively could cripple the economy of the State.

One parallel is that in neither case can all the detailed answers be known in advance. Because we went ahead with our highway program, we have spent 15 years in constantly improving our freeways and other highways as we have built—the modern freeway is certainly better from the standpoints of safety, capacity and efficiency than the ones we envisioned 15 years ago. We have been able to give the public consistently more highway for its tax dollar.

In the case of the water plan, all details have not been and cannot be fully worked out ahead of time. But that is no reason to delay the start of a necessarily long-term construction program to meet the needs which are confronting us right now. We have the same high quality of engineering and administrative talent in our water agency as we do in our highway agency. It can be relied on to give us the most water for our money.

The lack of detailed answers right now is naturally the basis for controversy about some aspects of the water program. It was also the basis for controversy about the highway program at the time of the Collier-Burns legislation in 1947.

If we had postponed action on the highway program in 1947 while we waited for all the arguments to be settled, we would not have today the transportation facilities which have contributed so much to the economic growth of our State. Our economy would have been strangled by hopelessly inadequate roads.

The people of this great State might consider a present and similar opportunity facing them in the field of water.



Artist's drawing of the combination railroad-highway bridge on U.S. Highway Alternate 40 across the West Branch appear after completion of the proposed Oroville Dam. The bridge, costing an estimated $9,200,000, is now under construction, to be completed in the summer of 1962.

California Highways and Public Works

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Vol. 39 July-August Nos. 7-8



FRONT COVER—Freeway construction on US 99 in the rugged Sacramento River Canyon looking north from Castle Crags State Park to towering Mt. Shasta in the background. The deep cut in the foreground is on Kettlebelly Ridge. The freeway passes to the left of the City of Dunsmuir which can be seen in the upper portion of the canyon. (See the article "Dunsmuir Freeway" in this issue.) *Photo by M. R. Nickerson*

BACK COVER—A photo of the reconstructed Mission Valley interchange which connects US 80 (upper level) with US 395 (lower level) in San Diego. The view, taken from the high ground south of the interchange, is northwestward. (See the article "US 80-395" in this issue.) *Photo by Bill Ruland*



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US 80–395

Mission Valley Interchange Reconstructed Under Heavy Traffic

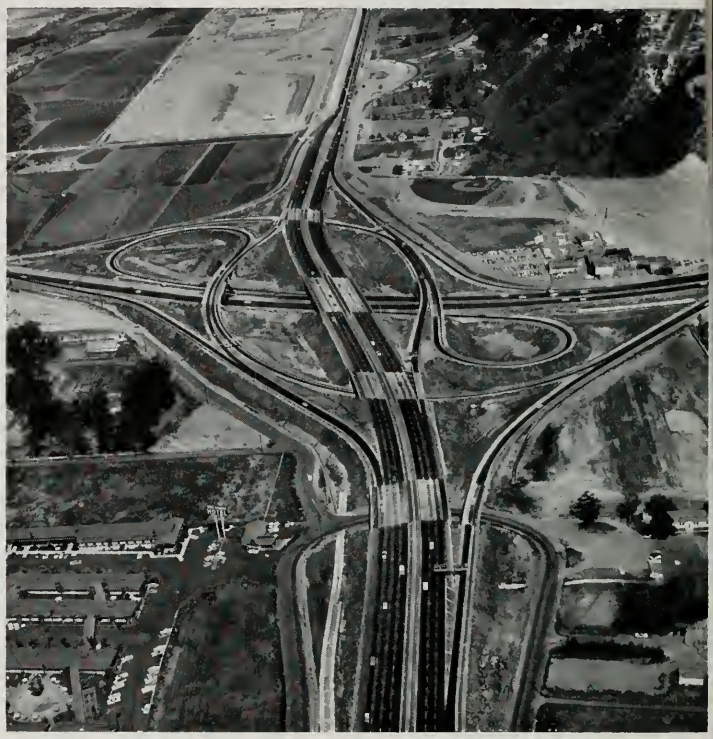
By J. R. CROPPER, Resident Engineer



THE CONSTRUCTION of any interchange on a freeway is a difficult task, but when an existing interchange with an average daily traffic of over 90,000 vehicles has to be reconstructed under traffic and still maintain a freeway type of traffic flow through the work, the task assumes entirely different aspects.

The original interchange, completed in April of 1948, was constructed as part of the Cabrillo Freeway (US 395) and separated Mission Valley Road and US 395. In June of 1953, Mission Valley Road was adopted as a portion of US 80 and a freeway resolution covering the newly adopted route was immediately passed. It was anticipated that Mission Valley Road (Now US 80) would be developed into an eight-lane freeway as soon as design could be completed and funds be made available.

The original directional interchange contained four semidirect as well as four direct connections and was designed for an hourly volume of 3,360 vehicles of mixed traffic. By 1957 the



ABOVE—An aerial view of the reconstructed US 80-395 Interchange in San Diego looking eastward along US 80. BELOW—A photo of the US 80-395 Interchange taken at night. The view is westward.





This photo taken during the reconstruction of the US 80-395 Interchange shows equipment crossing US 80 under traffic control.



A view of the construction area looking south along US 395 showing more equipment being taken across the roadway under traffic control.



A crane erects a huge sign bridge that will span the US 395 roadway in the interchange area.



This northward view along US 395 shows heavy grading adjacent to the traffic lanes.



A photo showing typical traffic density during the construction of the US 80-395 Interchange.



A southward view during the construction of the interchange showing completed bench cuts in the background.



This westward view shows the recently completed section of US 80 west of the US 395 Interchange. The white building in the distance is the Serra Museum. Separation structure in the foreground is the Presidio Park Overcrossing.



A section of Sign Route 67 in the Grassmant Summit section just south of US 80.



Looking north along US 395 during reconstruction showing concrete base operations adjacent to traffic.

actual counts had increased to 4,400 vehicles at peak hours.

Interchange Contract Awarded

On November 20, 1957, a contract was awarded to the Griffith Company of Los Angeles for reconstructing the existing Mission Valley interchange at the junction of US 80 and US 395. All lanes and ramps of the completed project were opened to traffic in October 1959.

The work of reconstructing the original interchange involved grading and paving one six-lane freeway and one eight-lane freeway, constructing five bridges, partially removing and reconstructing two bridges, widening one bridge, and constructing and removing one temporary bridge.

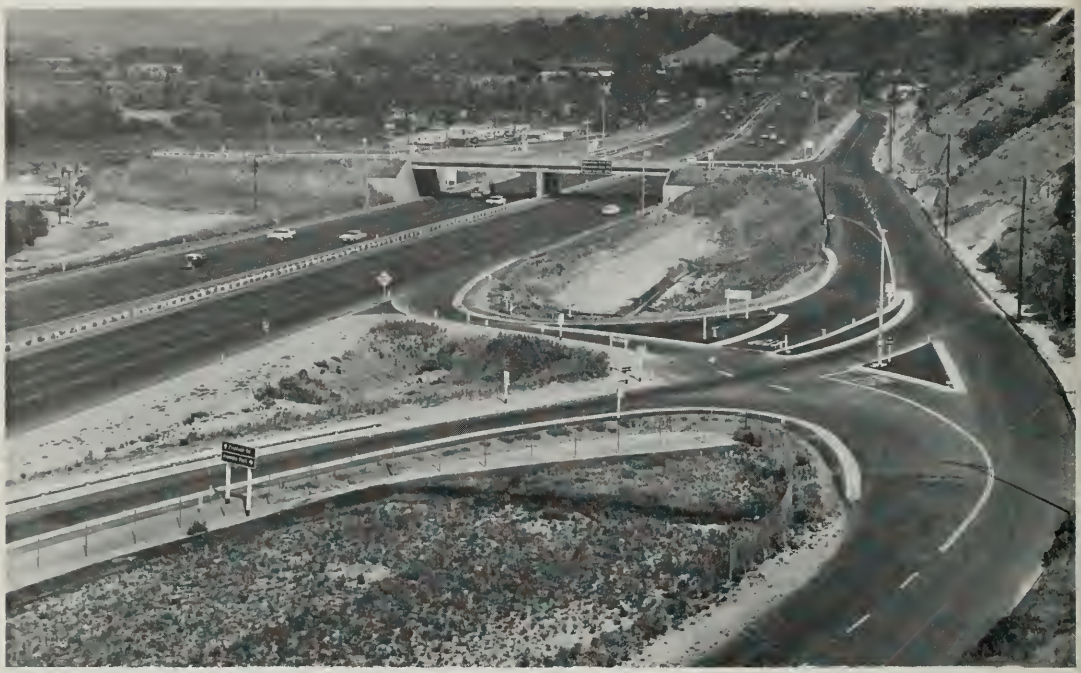
In order to keep a smooth flow of freeway traffic through the area, the work schedule was set up in four stages with two to three phases in each stage and 4 to 15 operations in each phase. Included in these various stages and phases was the construction and removal of 18 detours. These detours were constructed to high struc-



An aerial of the old US 80-395 Interchange before start of construction. The view is southwest.



An aerial view of the new US 80-395 Interchange looking south along US 395.



Another photo of the new section of US 80. The view is eastward toward the US 395 Interchange in the background.

tural and geometric standards because of the large traffic volumes. The main US 80/395 separation structure was constructed of prestressed concrete girders in order to prevent any inconvenience or interruption to the freeway traffic on US 395.

Roadway Excavation Moved

In addition to the ever-present dangers of working alongside high-speed traffic, it was necessary to move large volumes of roadway excavation across various traveled ways to new embankment areas. This was accomplished with large scrapers, which crossed the traveled ways at equipment crossings controlled by flagmen. The contractor was required to suspend all operations that would interfere with public traffic between 6 a.m. and 8.30 a.m. and 3.30 and 6 p.m., which were the peak traffic hours.

To illustrate the difficulties encountered and the degree of scheduling required by the contractor, it was necessary to distribute the placing of 14,650 cubic yards of portland cement concrete base pavement over 72 different working days. This is an average of only 200 cubic yards per day, which is only 20 percent of normal expectations for production on this type of work.

The existing lighting system of 64 street lights (or their temporary or permanent replacements) were kept in operation throughout the entire time of construction. This entailed the use of 17 temporary poles and numerous temporary services and circuits.

Traffic Is Detoured

One of the most difficult problems to be faced was the switching of traffic from old pavement to detours and from detours to completed work. This required precise timing between the contractor, state engineers, and the state traffic stripe painting crew. All possible signing, striping, etc., was performed before each traffic change, thus leaving only a minimum of work at the last minute. It usually proved most satisfactory to stop all traffic in the area concerned for a minute or two and make the necessary signing adjustment, then have the flagmen give oral instructions to the first few vehicles before directing them to the newly opened pavement.

Another interesting feature of the work was the installation of the 143-foot span sign bridge over nine lanes of US 395. During the period of erection, for safety reasons no vehicles could be allowed on this section of the roadway. It was also obvious that to stop traffic a few hundred feet each side of the sign area for any extended length of time would create a severe traffic jam.

After consulting with the San Diego Police Department, it was decided to divert traffic to alternate routes at predetermined locations that would cause as little confusion as possible to the traveling public. With the aid of the police department's radio patrol cars, contractor's flagmen, advance notice in the newspapers and on radio and television, and special detour signing, the plan was put into operation.

Fresno Freeway

Northern Extension Eliminates Last Three-lane Section on Highway 99

By NELSON E. HUMISTON, Resident Engineer



On Friday, May 13, 1960, six pretty Fresno State College coeds defied superstition to form a living barrier across the northbound lanes of the seven mile northerly extension of the Fresno Freeway between Clinton Avenue and the San Joaquin River at the Madera county line on US Highway 99.

The occasion was the dedication ceremony conducted by the Fresno City and County Chamber of Commerce, held at a site on the new route between Dakota and Ashlan Avenues.

Chester H. Warlow of Fresno, vice chairman of the California Highway Commission, Assemblyman Bert DeLotto, Assemblyman Charles B. Garrigus, Supervisor Norman Foley of Fresno County, and Oliver M. Jamiesen, president of the Chamber of Commerce, were the principal speakers. Assistant Director of Public Works T. F. Bagshaw and other state and county officials also took part in the ceremony. At its conclusion the pretty barrier chain swung to one side and traffic began to pass through the project.

Becomes County Road

With the opening the last remaining piece of three-lane highway on US 99



This aerial view northword shows the Tower Overcrossing and Ashlan Avenue Interchange on the new freeway section of US 99. Old highway at right.



This view southward shows the Herndon Avenue Overcrassing, at the north end of the project. Old highway at left.



Looking narth olong the new US 99 freeway section ot Highway City. Shaw Avenue interchonge in the fareground.

in the State of California was relegated to the status of a county road.

In 1916 motorists heading north from Fresno faced a sign that read, "Motorists attention! You are on your honor. Fresno County has no speed cops. Drive so they will not be needed. Speed limits 30 miles per hour." Unfortunately since that time the numbers and behavior of the motorists traveling the route had made the sign obsolete. The three-lane highway constructed in the early 1930's had become just as obsolete.

Planning for its replacement started during World War II and a considerable amount of the necessary right-of-way at each end of the route had been purchased. Lack of construction funds caused construction to be deferred and the plans were revised to provide for a full freeway on a route some distance to the west of the existing.

Pipe Crossings Installed

The new route runs generally through one of the major fig producing areas of the world. So that the large fig groves could remain in operation, it was necessary to construct a considerable number of irrigation pipeline crossings. Some of these facilities were built by right-of-way contracts prior to the beginning of construction on the freeway itself. The remainder was built concurrently with construction of the freeway.

The project provided for interchanges at the three major county roads, Ashlan Avenue, Shaw Avenue and Grantland Avenue. A double overhead carries the freeway over the Biola Branch of the Southern Pacific Railroad. Braid-type overcrossings were constructed at Herndon Avenue and at Dakota Avenue to permit local traffic to have access to and from the existing highway which now serves as a frontage road lying to the east of the freeway. In addition, bridges were constructed over the Herndon Canal of the Fresno Irrigation District.

Flooding Safeguards

Drainage fields were constructed near the depressed areas at Ashlan and Shaw Avenues to provide storage for



The electronically controlled and guided slip form paver in action.



The "monster" achieved a production rate on cement-treated subgrade of 6.4 cubic yards a minute.

the runoff of storm waters. Eight 48-inch drain wells were constructed in the Ashlan Avenue drain field to provide additional capacity.

The major portion of the items involved in the project were constructed conventionally. The contractor requested and received permission to place concrete pavement with the slip form paver that was described in Mr. Leigh Spickelmire's article in the January-February 1960 issue of *California Highways and Public Works*. This was the first such operation in this district.

Use of this electronically controlled and guided paving machine enabled the contractor to achieve a high production rate on cement-treated subgrade since the elimination of the conventional paving header-boards enabled the cement treatment to proceed without delay due to their placing. In order to expedite this work some unusual methods and equipment were improvised.

Base Is Laid

Control stakes were placed left and right of the proposed edge of pavement at a uniform elevation below the plane of the pavement surface. From these stakes, "blue tops" were placed by the contractor to closely control his subgrade construction. After construction of the dirt subgrade an initial 4" x 24' layer of untreated rock base was placed and compacted. Upon this surface, an 8⅔ cubic foot per lineal foot windrow of untreated base was spread using a shop modified spreader box. The volume of material placed was very closely controlled by weight based on the in-place weights determined from the preceding layer. The windrow of material was placed as far in advance as the capacity of the plant would permit.

Immediately prior to mixing, a distributor truck deposited cement on top of the rock. The windrow was then mixed with a shop-built mixer affectionately dubbed "Monster."

The "Monster" was constructed by the contractor in his shop from parts salvaged from many other construction machines. The chassis was 11 feet wide and 25 feet long and was mounted on three axles. The front axle came from a self-propelled crane carrier and the others were salvaged from Mack dump trucks.

Hydraulic Elevator

The front of the machine consisted of a hydraulically controlled bucket elevator which picked up the entire windrow of material and discharged it onto an enclosed belt conveyor that in turn fed the material to the pugmill.

The pugmill mixer was a double-shafted unit 7 feet wide and 10 feet long. It was provided with twin tubular mixer shafts rotating at 78 rpm. Two diesel engines were mounted to supply the necessary power. One motor powered the elevator and drove the mixer down the road; the other drove the belt conveyor and the pugmill.

After mixing, the processed material was deposited on the roadbed in two windrows. Three motor graders then handled the final spreading of the material. No segregation of any extent resulted from the use of this method. Two pneumatic rollers and a 12-ton three-wheeled steel roller provided compaction. Final trimming of the subgrade was performed by a motor grader equipped with an electronically controlled mold board. The compacted material was trimmed to the tops of the "blue tops." Profile index runs on the subgrade so constructed indicated a profile index of less than 10 inches per mile.

The contractor on the project was Griffith Company of Los Angeles. Mr. Hal McGregor and Mr. Ernie Arant were project superintendents for the contractor. The work was performed under the supervision of District Engineer W. L. Welch. Mr. J. M. McDowell was Construction Engineer. Final construction cost was $3,325,000.

San Jose Freeways

Major Interchange, Other Jobs Described

By HAIG AYANIAN, Assistant District Engineer—Construction

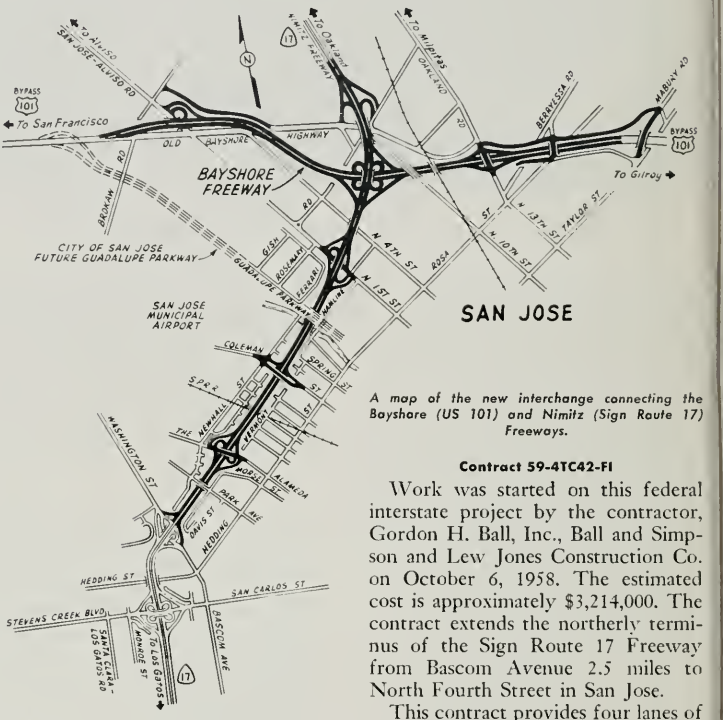


The San Jose area of Santa Clara County is demonstrating an explosive growth. Subdivisions are replacing the orchards of prunes and apricots at a bewildering rate. The traffic generated by such growth has created enormous headaches for local governments in this area much as it has in many other areas of California. This condition has been aggravated by the addition of through traffic heading for the hinterlands or the beach.

The days of sluggish and tortured traffic along the old San Jose-Los Gatos Road are gone, much to the gratification of Bay area motorists. No longer must they endure a two-lane highway, cluttered by numerous fruit stands, crossed by a myriad of country and residential streets, and jammed by a seemingly unending stream of vehicles. Bay area motorists bound for the popular summer resort of Santa Cruz can now travel unimpeded through the San Jose area.

The last link in the 75-mile Sign Route 17 Freeway between Oakland and Los Gatos was provided on June 21, 1960, by the opening of Contract IV-59-4TC42-FI from Bascom Avenue to North Fourth Street in San Jose together with the simultaneous opening of a portion of Contract IV-60-4TC2-FI from North Fourth Street to a connection with the Nimitz Freeway at Bayshore Highway (US 101 Bypass). These and previously completed projects, totaling approximately $15,000,000 excluding rights-of-way, provide freeway connections through San Jose to south of Los Gatos.

In addition to the newly opened leg of SSR 17, the September completion of the remainder of Contract IV-60-4TC2-FI will provide a section of Bayshore Freeway on new alignment through San Jose with a cloverleaf interchange at the intersection of the Nimitz and Bayshore Freeways.



A map of the new interchange connecting the Bayshore (US 101) and Nimitz (Sign Route 17) Freeways.

Between this project and the $3,465,000 Contract IV-60-4TC1-FP, completed in May from the San Mateo county line to Stierlin Road in Mountain View, two contracts have recently been awarded which will complete Bayshore Freeway from San Francisco to San Jose. These two projects, Contract IV-60-4TC71-F and Contract 61-4TC10-FP, will cost approximately $10,000,000 and will cover a total length of 11.9 miles between Stierlin Road and Brokaw Road.

A more detailed review of these recent and current projects follows:

Contract 59-4TC42-FI

Work was started on this federal interstate project by the contractor, Gordon H. Ball, Inc., Ball and Simpson and Lew Jones Construction Co. on October 6, 1958. The estimated cost is approximately $3,214,000. The contract extends the northerly terminus of the Sign Route 17 Freeway from Bascom Avenue 2.5 miles to North Fourth Street in San Jose.

This contract provides four lanes of a future six-lane divided freeway paved with portland cement concrete and includes seven major structures, with frontage roads and ramps. These structures are: the Park Avenue overcrossing, a reinforced concrete box girder with a length of about 159 feet; the Guadalupe Parkway overcrossing, consisting of two parallel bridges, each about 182 feet long and constructed of welded steel girder spans; the Guadalupe River bridge, consisting of two parallel bridges approximately 205 feet long, also constructed of welded steel girders and a concrete deck; the US 101 (El Camino Real) separation, a reinforced concrete box-girder bridge about 200 feet long; the Laurel Street overhead, a pair of parallel, precast, prestressed and reinforced con-

crete girder bridges each consisting of three spans totaling about 208 feet; the Coleman Street overcrossing, a single reinforced concrete girder bridge approximately 288 feet long; and the North First Street undercrossing consisting of two parallel welded steel girder bridges each about 172 feet long.

All these structures are founded on concrete piles. At two of them, pumping plants were constructed to provide drainage for the depressed sections.

The general route of this project traverses a cross section of the City of San Jose. Portions of it pass through residential, agricultural and industrial areas. Part of the freeway which is depressed below the surrounding area, exposed an underlying stratum of a highly plastic clay. It was necessary to overexcavate this clay in order to provide a suitable base for the roadbed. Construction problems were further aggravated by the fact that this region has been sinking over a period of years, presumably due to the lowering of the water table by intensified pumping for irrigation purposes.

The contractor was represented on the job by Superintendent Hadley E. Bacon and the State by Resident Engineer W. S. Smith and Bridge Department Representative P. N. Olson.

Contract 60-4TC2-F1

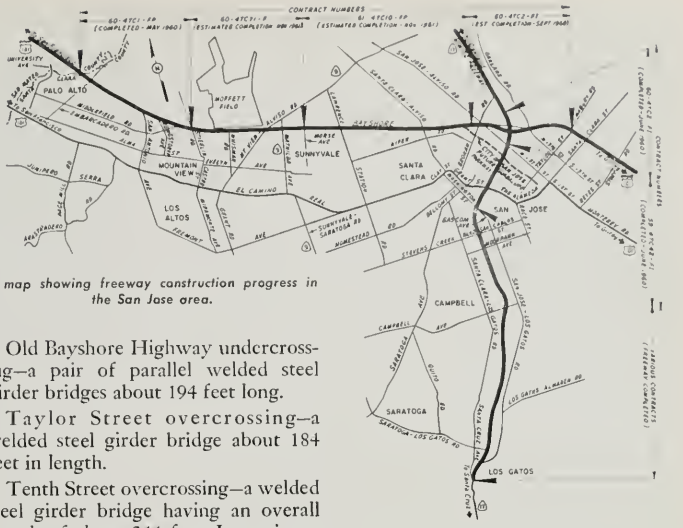
The same contractor was the successful low bidder and started work on February 9, 1959. The cost of this 4.1-mile project will be approximately $4,350,000. The contract provides in general for a four-lane, ultimate six-lane, freeway with nine major structures. The freeway consists of concrete pavement with necessary ramps and frontage roads.

The major structures are as follows:

North First Street undercrossing—a pair of similar parallel welded steel girder bridges with an overall length of about 214 feet.

North Fourth Street undercrossing—a pair of welded steel girder bridges, each with an over-all length of about 135 feet.

Sign Route 17/Bayshore Freeway separation—a pair of similar parallel welded steel girder bridges each having an overall length of about 197 feet.



A map showing freeway construction progress in the San Jose area.

Old Bayshore Highway undercrossing—a pair of parallel welded steel girder bridges about 194 feet long.

Taylor Street overcrossing—a welded steel girder bridge about 184 feet in length.

Tenth Street overcrossing—a welded steel girder bridge having an overall length of about 244 feet. In conjunction with this structure a pumping plant was constructed to provide for the drainage of the depressed section of freeway in this area.

North San Jose underpass—a riveted structural steel girder bridge of two spans, each having a length of about 59 feet, carrying the Southern Pacific railroad lines over the freeway.

Oakland Road/Bayshore Freeway separation—a welded steel girder bridge with an overall length of about 188 feet.

Berryessa Road overcrossing—a welded steel girder-type bridge having an overall length of about 185 feet.

In conjunction with the construction of the depressed section of the Bayshore Freeway on this contract, it was necessary to make extensive use of temporary detours in order to handle the existing traffic with as little inconvenience as possible.

The plastic stratum mentioned previously was encountered to an even greater degree in this area, and an extra foot of subbase material was placed.

The Berryessa spur of the Southern Pacific railroad was completely relocated as a part of this project to eliminate several grade crossings. The State's contractor graded the roadbed and the tracks were laid by Southern Pacific forces.

The concrete pavement work on both of these contracts was performed by the same crew as one project. This was done by means of a slipform paver, the first use of this equipment in District IV. Details of this slipform paver have been discussed previously in other issues of this magazine.

Hadley E. Bacon also represented the contractor on this project. L. A. Anderson was the State's resident engineer for the greater portion of the contract and the Bridge Department representative was M. H. Jacobs.

Contract 60-4TC71-F

Recently awarded Contract 60-4TC71-F will carry the Bayshore Freeway from Stierlin Road to Morse Avenue, a length of 5.9 miles. The work includes the construction of three new lanes of concrete pavement paralleling the existing highway and carrying the traffic eastward toward San Jose. The existing lanes will be resurfaced to carry traffic to San Francisco on three lanes and an additional future lane each way will be provided for. There are six major structures, including the Sign Route 9 separation.

This project is along the Moffett Field Naval Air Station and will entail



An aerial of the new Bayshare-Nimitz Freeways interchange in San Jose. The view is southword olong the Nimitz Freewoy (Sign Route 17). The old Bayshare Freewoy (US 101 Byposs) crosses the photo nearest the camera. Beyond is the new Bayshare Freeway completed as port of the interchange construction.



Looking westword on US 101 (Bayshore Freeway) toward the new interchange with the Nimitz Freeway (left background).



Looking north on Sign Route 17 (Nimitz Freeway) with the Bascom Avenue-Washington Street Interchange in the foreground.



A westword view of the Sign Route 17 Interchange in Los Gotos. Sign Route 17 extends horizontolly ocross the middle of the photo passing under the seporotion structure ot the center.

the relocation of many of the Navy's facilities. A major item is the relocation of the Southern Pacific and U.S. Navy rail facilities which serve the air station. Approximately 4,500 feet of track will be required for relocating a portion of the spur. The Navy has given the State permission to use considerable quantities of used 95-pound rail which it has in stockpile. It will thus be possible to perform track work with a minimum of interruption of rail service to the Navy station.

It is estimated that the work will cost approximately $4,150,000 and will be completed late in the fall of 1961.

The contractor, L. C. Smith & Concar Ranch & Enterprises, is represented on the project by Anthony Bruno. The resident engineer for the State is E. W. Strandberg, assisted by R. L. Vance as Bridge Department representative.

Contract 61-4TC10-FP

This contract, also recently awarded, entails the construction of the final link of the Bayshore Freeway between San Francisco and San Jose and extends from Morse Avenue to Brokaw Road, a length of 6.1 miles. This contract calls for the construction of a six-lane, future eight-lane freeway from Morse Avenue to the Guadalupe Parkway now under construction by the City of San Jose and planned for concurrent completion with Bayshore Freeway. Again, the existing pavement will serve as one roadway and three lanes of concrete pavement will be constructed for the other. The portion from the parkway to Brokaw Road will be four lanes with provision for six in the future. Ten major structures will be constructed to provide a full freeway. The 125 contract items are estimated to cost $5,779,000 and the estimated completion is about November 1961.

W. G. Remington is the resident engineer assigned to the contract, and M. H. Jacobs is the Bridge Department representative. The contractor is the Allen M. Campbell Company of Santa Ana.

A co-operative agreement with the Santa Clara County Water Conservation and Flood Control District provides that the State, as a part of these two projects, will realign and widen the existing Guadalupe River channel. The State will obtain all channel material in excess of that required to fill in the old channel and reconstruct dikes. This provides a considerable source of the necessary borrow required for the roadway embankments.

The special provisions for both of the last two contracts allow the use of slip-form paving. It is anticipated that this method will be used and will involve the placing of different slab thicknesses. The two outer lanes of each roadway are designed to be 9″ in thickness and the other is 8″. The method of slip-form paving chosen by the contractor will be of considerable interest.

The completed contracts on S.S.R. 17 have been or are currently being landscaped. Oleanders in the median will provide an aesthetic and effective screen against headlight glare. The areas outside the shoulders and interchange areas will be further beautified with redwoods and other trees, shrubs and ground cover.

Planting Pleases City

CITY OF MENLO PARK
Menlo Park, California
San Mateo County
July 15, 1960

Mr. J. P. Sinclair
Asst. State Highway Engineer
P.O. Box 3366, Rincon Annex
San Francisco 19, California

Dear Mr. Sinclair:

The City Council has asked me to express its appreciation of the attractive landscaping of the Bayshore Freeway—Willow Road Interchange area. We had been advised that the project would be an excellent one, and it has certainly turned out as predicted.

The city is interested in planting the areas on both sides of the frontage roads and will soon submit plans for your landscape division's approval.

Very truly yours,
John R. Johnson
City Manager

Freeway Planner B. W. Booker Dies

B. W. (Barney) Booker, who as Assistant State Highway Engineer in District IV was in a large measure responsible for the concept and construction of the highway and freeway system in the San Francisco Bay area, died July 18. He had retired in May 1959. He was 68 years old.

To the time of his retirement Booker had served 28 years with the Division of Highways, the last seven of which were as Assistant State Highway Engineer in charge of District IV. During those seven years of his administration highway improvements costing many millions of dollars were effected.

These included completion of the James Lick Memorial and Bayshore Freeways from the San Francisco-Oakland Bay Bridge to Palo Alto; completion of the Nimitz Freeway between San Jose and Oakland; virtual completion of US 40 as a freeway connecting to the new parallel Carquinez Bridge, and construction on many other routes.

In all, Booker spent more than 16 years in District IV, having been appointed assistant district engineer in 1942 and promoted to district engineer in charge of operations in 1947. Five years later he became Assistant State Highway Engineer upon the retirement of the late J. H. Skeggs.

He was born in Topeka, Kansas, and came to California in 1899. He was educated in the San Francisco public schools, Polytechnic High School and the University of California.

Booker leaves his wife, Leota; a daughter, Mrs. Barbara Riffel of Stockton, Kansas; two grandchildren, and two sisters, Miss Niara Booker of Oakland and Mrs. Clara Stone of New York. A son, Lt. Robert Booker, was killed in action in World War II.

Booker made his home in Oakland.

Dunsmuir Freeway

Canyon Section Poses Engineering Challenge

By GEORGE E. BERRY, District Construction Engineer, and CHARLES R. YOUNG and MARK E. CESSNA, Resident Engineers



ON AUGUST 6, 1958, ground was broken for the Dunsmuir Freeway, the first portion of full interstate freeway to be let to contract in District II. By mid-August the contractor, McCannon Wunderlich Company and Wunderlich Contracting Company, had most of his larger operations well under way.

EDITOR'S NOTE:

This article describes some of the special engineering problems encountered in converting US 99 in the Sacramento River Canyon to Interstate freeway standards. It deals specifically with current construction work in the Dunsmuir-Castella area, near the Siskiyou-Shasta County line.

Other phases of the over-all Sacramento Canyon improvement between Shasta Lake and north of Dunsmuir, have been described in previous issues of this magazine, including a comprehensive background article in the May-June 1956 issue.

On June 13, 1960, the Department of Public Works awarded a $7,454,833.85 contract for the construction of six miles of freeway between Shotgun Creek and just south of Castella. This project, to be completed in 1962, will be the final link in 30 miles of continuous freeway and expressway through the Canyon on which full-scale construction was begun in 1954.

The terrain through which this project is being built presents a challenge to construction forces. The work consists of constructing a multi-lane freeway along the steep, unstable westerly wall of the narrow Sacramento River Canyon, which in many places has a natural ground slope that is as steep as 1½:1.



Slide removal operations on the Dunsmuir Freeway section of US 99. The Panaroma Undercrossing is in the foreground. Mount Shasta in background.

To further complicate matters the Southern Pacific Railroad is in many areas directly below the new construction; and in the case of the Dunsmuir Freeway there is an additional problem of building, for the most part, through an urban area.

As originally planned the designer envisioned the construction of two fill stabilization trenches, but as soon as the project got under way it became apparent that at least two and possibly four more of these trenches would be necessary.

A fill stabilization trench is a deep trench excavated in the original ground. This excavation is as deep as can be practicably drained. The sides and bottom are covered with a pervious gravel blanket, perforated pipe is placed to drain off the underground water, and the water is disposed of by means of an outlet trench. The trench is then backfilled with good local materials. Thus the trench forms a deep keyway of stable material to support the roadway embankment.

Ground Unstable

In several locations on the Dunsmuir project the ground was considered too unstable even to construct embankment stabilization trenches; therefore, a relatively new method of tapping off the excess moisture was used. This method consists of installing vertical drainwells and intercepting these with horizontal drains. Where it was not



An aerial of excavation operations on the "Big Fill." The existing highway curves through the fill area near the center of the picture; the railroad realignment is in the foreground.



An aerial of the "Big Cut" at the north end of Dunsmuir. The slide area still to be removed can be seen in the right foreground.

practical to siphon off the drainwells with horizontal drains, drainwells acted as risers to siphon off the water by means of a gravel blanket. This relieved the area in question of its excess moisture, which is the largest factor in the problem of subsurface instability.

The drainwells are 30-inch-diameter vertical holes drilled to a maximum depth of 48 feet, with a 6-inch-diameter perforated metal pipe placed in the center of each hole and then backfilled with drain rock. The drainwells are located in two rows and are spaced in 10 feet, center to center.

Outlets for the drainwells were provided by drilling horizontal drains into the general area of the vertical drainwells to intercept and drain off the water.

The effectiveness of the vertical and horizontal drainage combination was checked by repeated drawdown and outflow measurements.

Drainage System Checked

Both the well system of drainage and the stabilization trenches were checked to see that they functioned properly in collecting subsurface waters before fill operations were started. With the relief of the excess moisture these areas have become stable enough to allow the roadway embankments to be constructed. The cost of the stabilization work is approximately $600,000 which will constitute 15 percent of the contract, a small price to pay to insure against future embankment failures.

The grading in general consisted of excavating two large cuts. The location of one of these is at Gobbler's Knob, just south of the Castle Crags Avenue Interchange at the southerly end of the project. The other is the Penthouse, or Stonehenge, cut at the north end of the project. The maximum cut at Gobbler's Knob is approximately 212 feet, and at Stonehenge the maximum cut is 360 feet to main line and another 40 feet to the northbound off-ramp.

The origin of the name Gobbler's Knob seems to be in doubt, but the name Penthouse comes from the excellent view from the top of this cut.

The many large boulders encountered in this excavation, when stacked on the main roadway in preparation for shooting, were reminiscent of the monoliths at Stonehenge on the Salisbury Plain. This cut therefore also became known as Stonehenge.

Slide Problem

As in all the jobs in the Sacramento River Canyon, many slides have occurred. Over 90 percent of the cuts throughout the project have slid at least once. The resulting increase in roadway excavation due to slides will be about 15 percent, that is, about 250,000 cubic yards.

Several thousands of feet of horizontal drains have been installed in the uphill cut faces throughout the project in an attempt to arrest the problem of sliding. These have been partially successful, but generally the slides on this particular project have been the result of slip planes of serpentine clay. In these cases, it is not a problem of excess moisture but one of support. When the support is removed during grading operations down comes the cut, and the only corrective measure that can be taken is either to replace the support or to remove the slide to the slip plane. Since the highway could not be constructed if the former method were used, it has been necessary to resort to the latter.

At the present time all of the embankments have proved to be stable. This is a tribute to the previous jobs recently completed in the Sacramento River Canyon in which invaluable information was gained in the field of stabilization work in this type of terrain.

New Paving Method

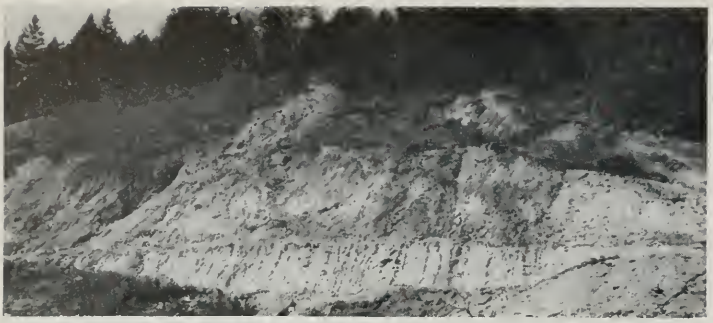
Another feature of this project is that it is the first project to be paved with Portland Cement Concrete in District II in almost 20 years. The subcontractor for this portion of the work, Gordon Ball, anticipates that he will use a slip-form paving method, which is a relatively new method of placing concrete pavement that does away altogether with header boards, thereby reducing the contractor's staff almost to half that necessary when using conventional methods.



Slide removal operations on the Castella section of the freeway, adjacent to the "Big Fill" area. View is northward.



Clearing operations (right foreground) on the slide at Castle Creek with Castle Crags in the background. New Castle Creek bridge, now under construction, can be seen on the right.



This is a phata af typical slide canditions encauntered in the Sacramenta River Canyan.



A typical harizantal drain installatian. Natice the ice at the autlet. The phata was taken in Janvary.



A typical bin wall installatian used alang this sectian at the freeway.

The completed project will consist of a four-lane divided freeway constructed to interstate standards. There will be three trumpet-type interchanges to facilitate on and off traffic. In addition, three other undercrossings are being constructed which will carry local traffic under the freeway to and from town. Upon completion of this project portions of the existing highway needed to carry local traffic will be relinquished to the county.

A portion of the existing highway will be buried under approximately 40 feet of embankment. It is interesting to note that at this location where the old highway is buried under the high fill, the old road was situated 50 feet up the steep hillside above the main line of the Southern Pacific Railroad. In order that the new embankment could be constructed it was necessary to erect extensive bin walls on the old road. Since their erection some settlements have occurred due to moisture and the consolidation of the underlying strata. In order to arrest these settlements, horizontal drains were installed under the bin walls.

Work Nearly Completed

Owing to the unusual length of the 1958 and 1959 construction seasons for this area the contractor is ahead of schedule with approximately 76 percent of the work completed. Barring unseasonable weather the project should be finished this year.

The second contract on the portion of US 99 which is being reconstructed to full freeway standards lies immediately south of the project under construction through Dunsmuir and passes through the small town of Castella and the easterly edge of the adjacent Castle Crags State Park.

North and south of Castella the narrow canyon, with its steep and unstable slopes, has hereto presented difficult problems to the road builder. Natural features did not create all of the problems, however. Where formerly there seemed to be only room for the Southern Pacific Railroad and the present two-lane highway, space had to be made for a four-lane divided roadway while keeping the other two facilities open to traffic.

The contractor, Gibbons & Reed Company, through judicious planning has been doing an excellent job. So well in fact, that during the past season 68 percent of the work was completed in 38 percent of the allotted time. This included moving over three million cubic yards of roadway excavation.

Construction Offers Problem

The maintaining of traffic through construction has been a problem of work scheduling and not essentially one of engineering. However, stage construction planned during the design stage of the project facilitated traffic movements with a minimum of delay. The engineering problem most bothersome was one of stability—how to construct the freeway above the present highway, above the railroad,



A typical stabilization trench used in construction of the freeway. The outlet trench is in the center foreground.

and above the river, and how to keep them there in that order.

Intensive studies and investigations were made by our laboratory to determine what measures would be required to stabilize the embankment foundations sufficiently to hold the heavy fills that would be necessary to construct this roadway to the required high standards of alignment and grade.

As a result of these investigations and upon laboratory recommendations of both district and headquarters, extensive systems of stabilization trenches, drainwells, and horizontal drains were constructed to obtain maximum fill support. The cost of all this hidden plumbing has averaged about $250,000 per mile over a distance of about 4⅓ miles.

Essentially all of the grading operation was completed during the past construction season. The fill stabilization treatment has apparently been very successful, as no noticeable settlement has occurred during the winter months.

Slides Add to Excavation

We seem to have learned how to keep the highways from sliding down the hills, but our success in keeping the hills from sliding down on the highways has not been so rewarding. Slides have added approximately 600,000 cubic yards to the total amount of excavation on this project. This is an increase of almost 25 percent over the planned roadway excavation.

To give an example of the type of terrain encountered, between Castella and Dunsmuir at one location within a centerline distance of only 1,200 feet, the highway passes from a cut section over 200 feet deep to a fill over 200 feet high and back into a cut which is approximately 250 feet deep. The "Big Fill," though only 600 feet long, contains over one million cubic yards of material. This fill has been constructed over what once was a loop in the channel of the Sacramento River. The river was diverted to another channel, of course, before the fill was constructed. This move also involved a realignment of the Southern Pacific Railroad. The depth of the deeper cut mentioned above is subject to change—it grows with each new slide. As a note of interest, during grading operations a tree standing upright was encountered in this cut approximately 40 feet below the surface of the existing ground, and the abrupt changes in the soil types encountered gave striking evidence that this was an area of old slides. This condition had previously been determined by borings, and it had been planned to stabilize the area by placing horizontal drains in the face of the cut slope and thereby tap off excess water that could cause instability. Sliding occurred before the stabilization treatment could be completed, however.

The first year of construction has seen the virtual completion of all of the grading operations. Paving will soon follow, and by the fall of this year the traveling public will be able to enjoy a few more miles of freeway driving.

New Toll Bridge

San Pedro-Terminal Island Structure Gets Under Way



CONSTRUCTION is expected to be fully under way this fall on the San Pedro-Terminal Island Bridge in the Los Angeles Harbor area, Southern California's first toll bridge project.

Preliminary construction work actually got under way in May, with groundbreaking ceremonies at the bridge approach site in San Pedro on May 28th.

The next step was taken by the California Toll Bridge Authority on June 6th, when it authorized the issuance of $7,000,000 in revenue bonds toward financing of the project, which is estimated to cost approximately $20,000,000 in all.

The final obstacle to advertising for bids on the bridge structure was the granting by the U.S. Navy of an easement for construction. This easement was received on June * * * and the call for bids issued promptly thereafter. Bids were scheduled to be opened on August * * * for the substructure and on August * * * for the superstructure work.

Bids were also solicited on the revenue bonds. These bids were scheduled to be opened August * * *.

The planned schedule for further construction provides for the start of approach construction in the summer of 1961, with the entire project to be opened for traffic in the summer of 1963.

The balance of the financing, in addition to the revenue bonds which will be redeemed out of bridge tolls, includes $2,000,000 each from the City of Los Angeles and Los Angeles County shares of highway user tax funds, as provided by legislation enacted in 1958; plus an estimated $9,000,000 in state highway funds.



This drawing superimposed on an aerial photo by a Division of Highways artist shows how the new San Pedro-Terminal Bridge will appear after completion.



Signalling the start of actual work on the San Pedro-Terminal Island Toll Bridge project, Governor Edmund G. Brown (left) and Assemblyman Vincent Thomas of San Pedro wield the traditional ornamented shovels at the project site on May 28. The two closest observers are (left to right) State Senator Richard Richards of Los Angeles County and Lieutenant Governor Glenn M. Anderson, who also took part in the open-air ceremonies attended by several hundred spectators.



Another artist's conception of the new bridge looking in the opposite direction from that on the preceding page.

The bridge will be located near the west end of Terminal Island, slightly north of the present route of the Terminal Island ferry which it will replace. The route of the bridge and approaches was recently adopted as a freeway by the California Highway Commission. The bridge will serve as part of a connecting link, designated by the Legislature, between the Harbor and the Long Beach Freeways.



This sketch shows the lane widths on the San Pedro-Terminal Island Bridge.

The toll project will be about 7,400 feet long. This includes about 4,000 feet of approach structure, 900 feet of approach fill, a 1,500-foot span between the two main suspension towers, and two 500-foot side spans between the main towers and the anchorages on either side.

The bridge will have four traffic lanes. It will have 185 feet of vertical clearance above mean high water.

On the San Pedro side, the bridge approach will cross over and connect with Harbor Boulevard near Regan Street. It will also connect with Pacific Avenue near Front Street. Provision will also be made for a direct connection with the present southerly terminus of the Harbor Freeway at Battery Street.

On Terminal Island, where the toll plaza will be located, the project will end on the south side of Seaside Avenue near Mormon Street.

Seattle Public Library
DEC 4 1961

US 101—Trinidad

Drainage, Slipouts Are Problem On North Coast Freeway Job

By R. C. WARNER, Resident Engineer



After 40 years, the tortuous portion of the Redwood Highway, US 101, between Little River and Trinidad in Humboldt County is being replaced by four miles of modern freeway. This new freeway is a complete relocation easterly and above the old highway. Construction work is moving into the final stages after the stabilization of a large slide which damaged three expensive homes that were within the area of movement, and the rebuilding of a major fill, all in addition to the many items of planned work. Many men and machines were used in the heavy clearing, the moving of over 1½ million cubic yards of earth, the building of three grade separations and interchange structures, three reinforced concrete arch culverts and the installation of several miles of underdrain pipe.

The construction work is being done under a single contract to John Delphia, Fred J. Early, Jr., Co. Inc., and L. A. and R. S. Crow, a joint venture. Estimated final cost of the project is $2,400,000.

The project is another link in the development of the Redwood Highway to a modern four-lane freeway. The northerly end of the project is 0.3 mile north of the City of Trinidad which is located 20 miles northerly of Eureka and overlooks the Pacific Ocean, Trinidad Bay, and Trinidad Head, a prominent coastal land mark. The name "Trinidad" resulted from a visit by early Spanish explorers during Trinity Sunday in June 1775.



Schematic illustration of slipout and corrective treatment on US 101 freeway construction near Trinidad, Humboldt County. Arrow 1—With new roadway almost to grade a slipout occurred. Arrow 2—Underground water undetected during preliminary investigations lubricated new embankment and underlying natural ground. Material was excavated to solid substrata. Perforated metal pipe was placed at the toe of the slipout area and then a blanket of filter material.

Good Alignment

The relocated highway will be a full freeway with two complete interchanges and one interchange providing for two main movements. The alignment will provide for maximum allowable speeds. The roadway will be a standard four-lane 60-foot all paved section with curbed medians through interchange areas.

The portion of Redwood Highway to be superseded was built in 1921 with horse drawn wagons and scrapers and the oldtime steam shovels. The 22-foot roadway was notched out of the bluffs bordering the Pacific Ocean and is a continuing series of curves having radii as low as 70 feet, many reversing, and the remainder separated by only short lengths of straight road.

The existing road provides many wonderful views of the Pacific Ocean, but any enjoyment of the vistas by the operator of a moving vehicle is precluded by the need for continuous scrutiny of the road ahead due to curvature and the type of traffic.

This portion of the Redwood Highway probably carries more logging and lumber trucks than any other road in the State. Loads of logs or lumber are spilled regularly on two particularly sharp curves on the existing road.

On the new freeway four deep canyons are crossed on large fills after the new line leaves the beach and bluff area near the beginning of the project at the mouth of Little River. Two major fills were also constructed in the climb from the beach area. The largest fill, crossing Luffenholz Creek,

contains 260,000 cubic yards of embankment and is 90 feet deep. Luffenholz Creek is carried in a large 14-foot reinforced concrete arch culvert 396 feet long.

The first large fill in the climb from the beach has its foundation on the ocean beach at the mouth of Little River and is protected from the erosive action of the ocean by heavy stone riprap. This riprap received and passed its initial trial during the heavy seas that pounded the shore during February 1960. Some of these seas carried drift across the existing highway at two locations within the limits of the project.

Subsurface Water Drained

In order to build roads in this coastal area of heavy rainfall, large quantities of subsurface water must be drained away from fill areas and subgrade. On this project 25,000 lineal feet of eight-inch perforated metal pipe, 90,000 cubic yards of stripping of fill areas and 65,000 tons of filter material were involved in providing for subsurface drainage and stabilization of fill foundation.

On all large projects unexpected situations are encountered, and on this project situations of some magnitude developed.

Three homeowners above a new high roadway cut on the freeways discovered cracks developing in their yards and driveways early in July 1959. As heavy equipment continued to remove earth from this cut, the cracks at the residences above continued to grow and extended through concrete floor slabs in the house. Doors became hard to open, indicating earth movement in the area.

Investigations soon revealed that the construction of this cut was activating a large, old landslide. It also became evident that any large movement of the slide would endanger other expensive homes in the area and a county road, as well as having a detrimental effect on the freeway cut.

Investigation Made

The earthmoving operations were quickly halted while a complete investigation was undertaken and remedial measures determined. The slide



This view is looking north from the beginning of the project above Little River. Communities in the background are Moonstone Beach (left of highway) and Westhoven (middle background).



A northward view of the project with the Trinidad Interchange under construction in the background.



A photo of the freeway under construction with Little River Beach to the left. Note the heavy growth of grass on the planted slopes resulting from winter rains in Humboldt County.



The big slide mentioned in the accompanying article was drained with horizontal drains, two outlets of which are shown in the above photo. The paved gutter prevents erosion of the cut slopes by water from the drains. The slopes were seeded and the heavy growth of grass protects the cut slopes from erosion.

appears to have been stopped after a maximum movement of only inches by the following treatment. The grade of the freeway was raised a total of 15 feet to provide a buttress against the sliding movement, and a number of horizontal drains were installed to drain the subsurface water in the area which was lubricating the slide mass.

As a result of the damage to the houses, the property was purchased by the State in connection with right-of-way acquisition. The houses were subsequently sold at public auction in the usual manner and the successful bidders have now removed the improvements from the area and are relocating them on other sites.

Shortly after the slide stabilization work had been undertaken, further construction difficulties were indicated when a portion of a major side hill embankment to the north of the slide began to slip away. The fill was just being brought to grade when the slipping was discovered. Instability of the original ground supporting the new embankment was the cause of the slipout. Original investigation of the area did not disclose the existence of a 20-foot layer of a plastic blue clay overlaying a stable sand formation. Unfortunately, preliminary borings apparently encountered some float rock and visual evidence did not indicate any foundation problem.

A stabilization trench was constructed along the lower edge of the fill keying into the stable sand, and the fill reconstructed with the handling of 90,000 cubic yards of earth involved in the repair work. The control and disposal of subsurface water was provided for by a drainage system consisting of filter material and perforated metal pipe. The stabilization trench was typical of those used on many projects in District I where unstable embankment foundations are encountered.

Sands Vary in Depth

The soils within the job limits are predominately fine cohesionless sands originating from beach deposits. Small quantities of beach gravels and float rock were also encountered. The sands vary in depth from approximately 100 feet to only a few feet

deep at the northerly end of the project. The underlying material is blue clay with rock fragments. Some hard rock is exposed at different locations through the project and some was encountered in cuts.

The large slide, described earlier, extended 1,200 feet along the centerline of the new freeway and back of the slope lines 100 to 300 feet. The slide mass consisted of sand 50 to 60 feet in depth lying on the blue clays. The blue clays had a steep pitch toward the ocean. The sand was saturated from the contact with the clay to several feet above the clay. Undoubtedly the slipping was taking place in the saturated sand or on the contact plane between the sand and clay or was a combination of these movements.

Attempts to install horizontal drains and produce a flow of subsurface water proved to involve more than the ordinary problems encountered in horizontal drain installations. It was not difficult to drill the holes to intercept the water bearing materials, or to install the drainpipe. However, the wet sand and silt mixture had the consistency of a thin grout. Once the pipes were installed the wet sands would flow through the perforations of the pipe and along the pipe for varying distances then stop, forming a very good plug.

The successful installations, producing a satisfactory flow of water, resulted from cleaning the pipes with a water jet. Water was carried to the sand in the pipes by a ½-inch galvanized pipe inserted into the horizontal drain. Jetting was continued until the end of the horizontal drainpipe was reached by the ½-inch pipe jet and the volume of sand being washed out decreased. Some of the drains had to be jetted a number of times before any flow was obtained. No water was obtained from two or three of the installations because the sand continued to enter the drainpipe as fast as it could be washed away.

Pipes Become Clogged

Another problem in the jetting operation was to keep the ½-inch pipe from sanding in and blocking the flow. One jetting pipe did get sanded in and was salvaged only after the entire installation was pulled.

A flow of water was obtained from about two-thirds of the drains installed, with three or four of the 20 drains installed apparently disposing of the majority of the subsurface water in the area. A peak flow of 30,000 gallons per day was obtained. This flow dropped to 3,400 gallons per day in February 1960 and then increased to 12,000 gallons per day in March 1960.

Drains installed varied in length from 100 to 220 feet. It was found best to use 20 to 40 feet of perforated two-inch pipe with the balance solid pipe. Any greater length of perforated pipe caused a jetting problem. Two five-foot-long wellpoints were tried and the sand did not come into the wellpoint, but very little water did either. Jetting apparently cleared a cavern around the pipe which collected the water.

Horizontal drilling was tried with both an auger type drilling machine and a type using water as a circulating medium. Even bentonite mud was used to line the drill hole. The auger type proved to be more satisfactory.

At this writing the grading is practically complete.

The surfacing and paving operations should be expedited somewhat by the fact that all the necessary aggregates were produced during the winter and stockpiled at the jobsite and at a nearby commercial paving plant. At the jobsite very sizeable stockpiles have resulted from the production and hauling of 144,000 tons of subbase, base and cement-treated base aggregates. At the commercial plant 34,000 tons of asphaltic concrete aggregates await mixing and placing on the project.

It is anticipated that the project will be completed during the latter part of the summer providing a long-needed modern freeway to adequately serve present day traffic.

The old section of highway with its beautiful vistas of the rugged ocean shoreline will revert to the County of Humboldt. It will serve many properties along its route as well as providing a scenic ocean drive which can now be enjoyed at leisure.

Womack is Elected WASHO Vice Pres.

State Highway Engineer J. C. Womack was elected vice president of the Western Association of State Highway Officials on June 24 at the closing session of the association's 39th annual conference, held in Portland, Oregon.

WASHO will be headed for the ensuing year by G. Bryce Bennett, State Highway Engineer of Idaho. He succeeds Fred C. Quinnell, Jr., State Highway Engineer of Montana, as president of the 14-state organization.

Forrest Cooper, Deputy State Highway Engineer of Oregon, was elected secretary-treasurer. Named to the executive committee were T. D. Sherard, director and chief engineer of the Alaska Division of Highways; D. B. Dixon, chief highway engineer of New Mexico; Joseph J. Marsh, Colorado highway commissioner; and Ernest J. Ketcham, chairman of the Washington State Highway Commission.

IN MEMORIAM

District IV

Gerald V. Cole, Junior Civil Engineer, 6-13-60.

District VIII

Edward H. Cable, Hwy. Equip. Oper. Lab., 6-2-60.

Lloyd T. Fish, Highway Foreman, 5-16-60.

District X

Frank A. Rodemer, Hwy. Equip. Oper. Lab., 5-4-60.

District XI

James D. McCain, Hwy. Equip. Oper. Lab., 6-14-60.

Headquarters Shop

Albert L. Zindel, Skilled Laborer, 6-21-60.

A major fire in the Town of Knights Landing necessitated the closure of US 40 Alternate for some 18 hours starting at 3 p.m. on June 5, 1960.

State Route 283

City, County, State Co-operate in Developing Important Freeway

By R. J. DATEL, City-County Projects Engineer



THE CALIFORNIA Freeway and Expressway System established by the State Legislature in 1959 added several new routes to the State Highway System within the San Diego metropolitan area. These were selected as a result of co-ordinated planning by city, county and state officials responsible for providing an adequate integrated transportation system for the area.

An example of this co-operative effort, not only in planning, but in financing, design and construction as well, is illustrated by a brief review of past, current and proposed activities along one of the new routes now designated as State Highway 283. Route 283 is described in the statutes as being located between the following termini:

(a) From Route 241 (an unconstructed Interstate Highway) near the north city limit of National City to Route 2 (US 101) and

(b) From Route 2 to Route 77 (US 395) near the United States Naval Air Station Miramar.

Route Not Adopted

The latter portion of the route between US 101 and US 395 will be discussed here. It should be emphasized that the adoption of a specific location for this highway between the above termini by the California Highway Commission has not yet been accomplished. However, advantages including traffic service and use of existing rights-of-way and constructed facilities could result in the adoption of a route which basically coincides with the location discussed below.

As early as during World War II the City of San Diego realized the importance of providing for a high-volume, north-south traffic artery from the National City area through east San Diego to military installations along US 395 on Kearny Mesa because of the direct access that such a route would provide to naval facilities at either end. Shortly after the war the city council adopted Wabash Boulevard, 40th Street and Ward Road as part of its major street and highway plan, and also designated these streets as major city streets, thus qualifying them for improvement from the city's share of state gas tax funds.

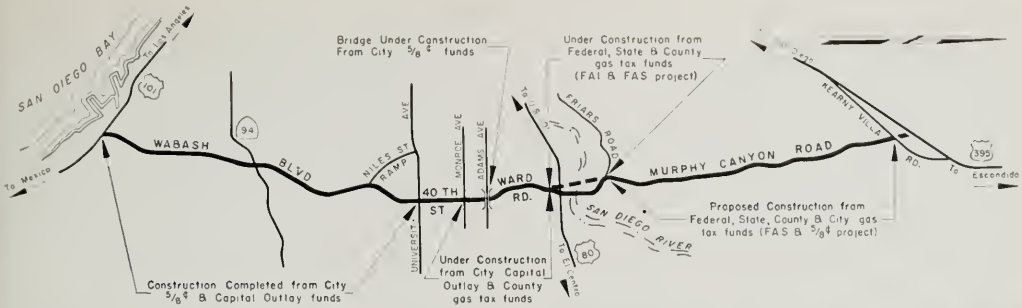
The locations of these streets coincide with the north-south portion of Route 283 between US 101 and US 80 of the adopted California Freeway and Expressway System.

In Master Plan

The County of San Diego also recognized the importance of the route and the board of supervisors included Murphy Canyon Road as part of the county master plan of highways as adopted in 1952. This road between US 80 and US 395 was placed in the federal-aid secondary road system, which permitted the use of federal



The above map shows the system of existing and proposed state freeways and expressways in the San Diego area.



This map of State Route 283 in the San Diego area shows the location of the projects discussed in the accompanying article.

The photo looking north along Wabash Boulevard, shows the new Sign Route 94 Interchange. The original interchange built by the city included the eastbound bridge on Sign Route 94 (dark surfaced structure near center of photo) and a portion of the cloverleaf and right-turn ramps. State construction of Sign Route 94 as an eight-lane freeway necessitated expansion of the interchange as shown in this photo.

and state funds to help the county finance future improvements.

In 1948 the City of San Diego began a long-range improvement program with gas tax funds. Wabash Boulevard and 40th Street between US 101 and Monroe Avenue, a distance of approximately 5.5 miles, was included. The sum of $175,000 was budgeted for preliminary engineering and right-of-way acquisition, followed in 1950 by $1,182,000 for construction. Additional money was later provided for this project, resulting in a total expenditure of preliminary engineering, right-of-way acquisition and construction between 1948 and 1955 of approximately $3,968,000. These funds financed the existing four-lane divided, limited-access facility between US 101 and 40th Street, and increased traffic capacity by the widening of 40th Street to University Avenue. Between University Avenue and Monroe Avenue, 40th Street functions as a four-lane, undivided city street.

City Designs Project

Engineering, including surveys, design, inspection, right-of-way acquisition and administration of construction contracts, was performed by the city in accordance with the laws and procedures relating to the expenditure of five-eighths-cent gas tax funds. Under this arrangement the Division of Highways approves budgets and plans and specifications, in addition to providing technical advice and assistance to cities.

The City of San Diego has long recognized the need for adequate planning, programming and financing of its major city streets in order to keep pace with the city's rapid population and motor vehicular growth. This growth can be vividly illustrated by comparing the 1950 city population of 334,387 with the 1960 city population of 555,000.

The city's positive program of providing adequate major street facilities includes:

1. Long-range planning of transportation needs integrated with other metropolitan area cities, the county and the State.
2. The annual preparation of a six-year capital improvements program listing major city street projects by priority.
3. The budgeting of 100 percent of its annual allocation of gas tax funds for major construction projects; (the law allows the use of a maximum of 40 percent of gas tax funds for maintenance of city streets, if a city so desires).
4. The annual provision for major street construction projects from city capital outlay funds in an amount approximately equal to the gas tax allocation.

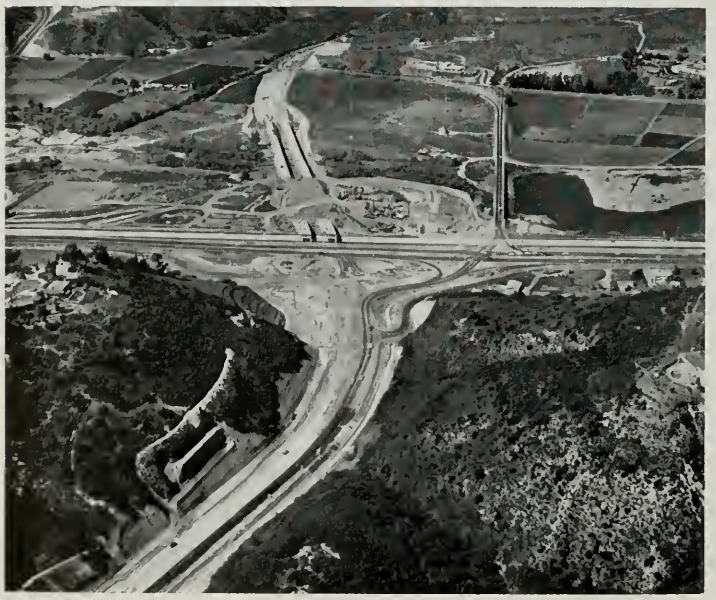
The work described above on Wabash Boulevard and 40th Street included financing from capital outlay funds in the approximate amount of $189,000 plus the construction of the Nile Street ramp which has provided an additional connection between University Avenue and Wabash Boulevard.

Co-operative Agreements

Current construction extends from Monroe Street, about 1.5 miles south of US 80, to Friars Road, about 0.6 mile north of US 80, under three separate contracts, resulting from three different types of co-operative agreements.

The first of these is the Adams Avenue overcrossing project which will carry city street traffic over Ward Road two blocks north of Monroe Street. This bridge is financed from $300,000 gas tax funds and is, therefore, included in the regular City-State 5/8-cent Memorandum of Agreement and is being constructed as a city contract.

The second project now opened to traffic, is the improvement by city contract of Ward Road, between Monroe Street and US 80. This divided, four-lane, access-controlled facility is the result of a co-operative agreement between the City and County of San Diego. The northerly portion of this project is located in the county. This job is financed from city capital outlay funds in the amount of $808,000 and from county gas tax funds in the amount of $180,000. Unlike city gas tax procedures, the expenditure of county gas tax funds is not administered by the Division of Highways. This city-county co-operative project does not, therefore, formally involve the State.



This aerial, looking northward along Murphy Canyon Road, shows US 80 running east and west through the center of the picture and Friars Road running east and west in the background.



The above photo is looking south along Murphy Canyon Road and Ward Road, with US 80 running horizontally through the center of the picture. New bridges over the San Diego River are in the foreground. Construction on Ward Road is a city-county financed project.

County-State Agreement

The last of the three projects currently under way is covered by a standard FAS county-state construction agreement executed for each county federal-aid secondary project, the financing of which normally includes federal, state and county funds. In accordance with state law in California, 87½ percent of the federal-aid secondary funds apportioned to California are reapportioned to the counties for expenditure on the county FAS highway system. The statutes also provide for state highway funds to be apportioned to the counties to help match these federal funds.

This particular project across the San Diego River at the mouth of Murphy Canyon is being constructed as part of a state highway contract on US 80. At the time plans were being prepared by the State for the US 80 project, the county requested that a second two-lane bridge be provided over the San Diego River to Murphy Canyon Road in addition to the one planned as a replacement for the existing two-lane bridge. It was agreed that the State would include the second bridge and add two lanes to the original design of Murphy Canyon Road from the river bridges to the north end of the project at Friars Road, and that the additional facilities would be financed as a county federal-aid secondary project. This $354,000 project is financed from $189,000 federal-aid secondary funds, $135,000 state matching funds, and $30,000 county funds.

City Uses Own Gas Funds

Construction planned for the immediate future is on Murphy Canyon Road, between Friars Road and Kearny Villa Road near US 395, a distance of 4.3 miles. This single project will include all three types of agreements just discussed. Basically the job is a co-operative city-county effort, with each local agency paying for the improvement located within its jurisdiction. The city has elected to finance its share from ⅛-cent gas tax funds, hence the need for a memorandum of agreement with the State, and the county's decision to use FAS financing for its portion will result in a county-state FAS construction agreement.

The construction of this portion of the route as an FAS project will result

in a limited-access facility built to state highway standards, both structurally and geometrically, from US 80 north to Kearny Villa Road. Proposed construction is for six-lane grading with an ultimate 22-foot median. The outside four lanes are to be paved with asphalt concrete over aggregate base and subbase. This improvement would permit this portion of the route to be adopted and used as a state highway without additional expenditures for many years to come.

Informal Contracts Occur

The processing of any county FAS project, from the planning stage to the final acceptance of the completed work, involves a great deal of co-operation among federal, state and county personnel. Although the federal government has delegated to the State the responsibility for the successful completion of county FAS projects, many informal contacts with U.S. Bureau of Public Roads' officials occur. The county is urged to do the required preliminary and construction engineering with its own forces. If requested by the county, the State will perform any engineering functions which the county is not equipped to handle.

All preliminary engineering for the Murphy Canyon Road project is being handled by the county, except materials investigation, testing and preparation of the materials report. After plans, specifications and engineer's estimate have been approved by the State, the county FAS projects are advertised, awarded and constructed as state highway contracts. Construction engineering forces consist chiefly of county personnel with help from state engineers, if required.

Bid Call This Summer

It is anticipated that the call for bids will be made on the Murphy Canyon Road project late this summer with construction beginning this fall. Financing of this job includes $570,000 ⅛-cent (city) gas tax funds, $335,000 county gas tax funds, $225,000 state matching funds, and $551,000 federal-aid secondary funds, totaling in all $1,681,000.

By way of summary, the completed, under way, and proposed improvements, which have all been initiated by local jurisdictions, along the 12.1 mile section between US 101 and US 395 will result in a limited-access, four-lane divided facility for a distance of 11.0 miles and a four-lane city street facility for 0.9 mile. The north 0.2 mile of this route is not planned for immediate improvement, because future traffic interchanges involving three state highway routes will eventually be constructed in this area.

The table below summarizes the financing made available to date for the right-of-way acquisition and construction of this route. The figures in the table are approximate only and are for the purpose of showing the magnitude of the overall project and the various types of financing used.

As previously pointed out, the above improvements have been a result of long-range planning many years before a state highway was considered through the area, yet financing and construction of projects has continued by the city and county even after the State Legislature designated a state highway to exist along the approximate route of these local roads and streets. It is anticipated that the existing traffic volumes which vary from 9,000 to 26,000 ADT along this route will increase to a range of 50,000 to 80,000 ADT by 1985.

Providing a usable, continuous traffic facility capable of moving large volumes of traffic through a metropolitan area over a long period of time with financing available to local jurisdictions and with improvements that basically could be utilized in the future as part of the California Freeway and Expressway System is a tribute to local legislative bodies and to the skill, foresight and co-operative spirit of administrators, engineers and planners of all jurisdictions engaged in furnishing the public with street and highway facilities.

The co-operative planning and constructing of this route is not unique in the San Diego metropolitan area. It is cited not as an unusual occurrence, but as a typical example of the collective effort expended by city, county and state officials in attempting to provide integrated transportation facilities for the area's exploding population.

This is the time when much is being written about the most effective means of governing the complex metropolitan areas of today and tomorrow, and terms such as federated cities, city-county consolidation, and regional government frequently appear in this literature.

The intergovernmental relationships, both formal and informal, discussed here show what is being accomplished in one phase of one metropolitan area by the use of existing tools and common goals.

Limits	*Length in miles*	*R/W or constr.*	*⅛¢ funds (City gas tax)*	*City Capital Outlay funds*	*County gas tax funds*	*State matching funds*	*Federal-aid sec. funds*	*Total*
COMPLETED								
Wabash Blvd. & 40th St. from US 101 to Monroe Avenue	5.5	R/W	$751,000	$34,000				$785,000
		Constr.	3,098,000	155,000				3,253,000
UNDER CONSTRUCTION								
Ward Road from Monroe Avenue to US 80	1.5	R/W		475,000	$3,000			478,000
		Constr.	300,000	333,000	177,000			810,000
UNDER CONSTRUCTION OR FINANCED								
Murphy Canyon Road from US 80 to 0.2 mile south of US 395	4.9	R/W	70,000		75,000			145,000
		Constr.	500,000		290,000	$360,000	$740,000	1,890,000
Total Funds			$4,719,000	$997,000	$545,000	$360,000	$740,000	$7,361,000

Third Tunnel

New Parallel Bore Through Berkeley Hills is Planned

By O. H. DEGENKOLB, Senior Bridge Engineer



The Broadway low-level tunnels are through the Berkeley hills between the City of Oakland and Contra Costa County. They consist at the present time of two 3,000-foot long tunnels which are parallel to each other and approximately 100 feet apart. The end portions are curved and join each other in single large portal buildings at each end.

The first tunnel through these hills was constructed in 1904 almost directly above the two existing tunnels. This early high-level tunnel was approximately 1,000 feet long, timber-lined, dark and narrow.

The 1960-61 State Highway Budget provides $10,000,000 for the Broadway Tunnel project. Bids are scheduled to be opened in Sacramento early this fall.

The first official action to provide a means of constructing a low-level highway through the Berkeley hills was taken in November 1926 in the form of an agreement between the City of Oakland and the counties of Alameda and Contra Costa. A Joint Highway District (No. 13) comprising the two counties was organized in 1929 to carry out the necessary engineering studies, design, legal functions, financing and construction of the project. The two present tunnels were completed and opened to traffic in December 1937 and have been in continuous service since.

At its 1960 session the California Legislature by concurrent resolution officially designated the Broadway



This artist's sketch shows how the Oakland approach to the Broadway Tunnel will look after completion of the new bore. The view is eastward, with the existing bores at the right and the new one at the left. The new patrol building above the new tunnel will house the controls for all three bores, and will be reached by the new service roads shown in the sketch.



An aerial of the Berkeley Hills looking from eastward showing the location of the existing and proposed tunnels.

low-level tunnel as the Caldecott Tunnel, in honor of the late Thomas E. Caldecott. Mr. Caldecott was an Alameda County Supervisor and president of the Joint Highway District when the original tunnel was built.

Strata Are Fractured

The geology of the location of the tunnels consists of shale, sandstone and chert, which are highly fractured, and soft dikes which exist in great numbers. Despite the use of very heavy timber supports two serious cave-ins occurred during the construction of the two existing bores. The first cave-in occurred at a point where there was nearly 100 feet of rock above the tunnel and killed three workmen. The caving extended all the way to the surface and left a large depression in the side of the hill. The second cave-in occurred at a point beneath the highest point of the hill and caused considerable damage to the unfinished tunnel and equipment.

The proposed third bore will be 150 feet north of the existing northerly tunnel and will be approximately 500 feet below the summit of the ridge. It will be on a 4 percent grade descending from the Orinda end down toward Oakland. Both ends will be on curves in order to provide smooth alignment into the canyons at each end.

The existing tunnels have 22-foot roadways with a 3-foot sidewalk on the left and one-foot-wide curb on the right of traffic. They have a minimum vertical clearance of 14'-10" above the roadway surface. The new tunnel will have a 28-foot roadway with a 4-foot sidewalk on the right of traffic and 2½-foot curb on the left with 17 feet vertical clearance. The existing 22-foot roadways are undesirably narrow for carrying the heavy volume of fast moving traffic which now uses the tunnel.

When all three tunnels are completed, the southerly existing tunnel will be used for traffic from Oakland to Orinda and the new third tunnel will carry traffic from Orinda to Oakland. The traffic in the center tunnel will be one-way but the direction will be changed to accommodate the heavier direction of travel at peak hours.

Tunnels Are Connected

Three adits, small tunnels four feet wide by seven feet high, will be constructed to connect the third bore and the nearest existing tunnel. These small tunnels will be a safety feature and construction aid during the driving of the third bore and will facilitate maintenance and emergency operations after the tunnels are in use.

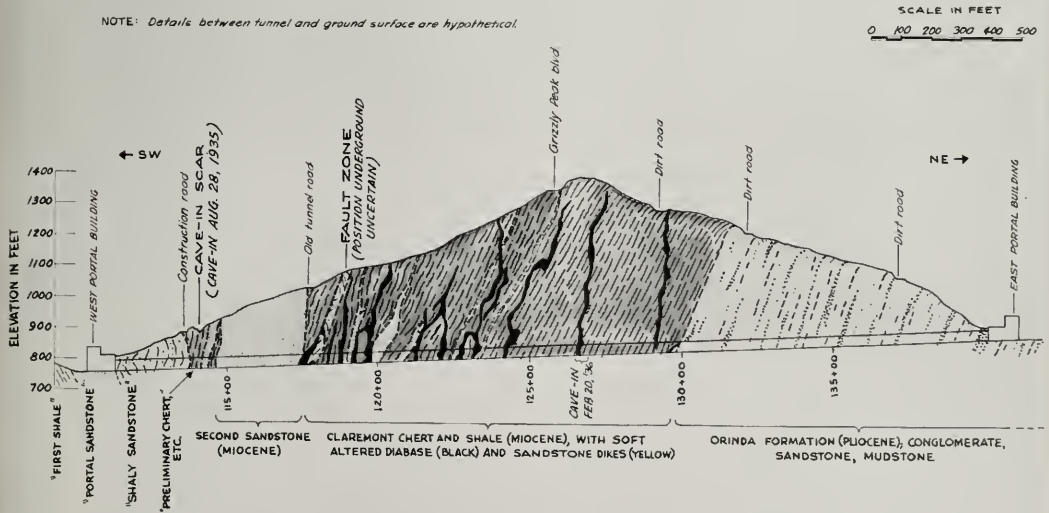
At the completion of the construction of the third bore it is planned to refurbish the existing two bores. All three of the tunnels, and ultimately all four, will be operated from the new westerly portal building.

The fact that the proposed bore is much larger than the two existing ones will present additional problems in tunneling. However, with the experience gained in the driving of the existing bores, more modern tunneling equipment which is now available, the fact that structural steel is being specified for most of the temporary tunnel support and will be paid for as a contract item, and the requirement that the concrete lining be placed as close as practical to the front face of tunnel excavation, construction difficulties should be more readily anticipated and overcome.

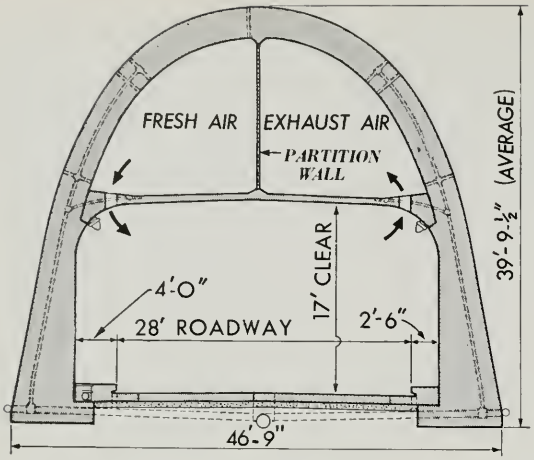
Tunnel Ventilation

The largest single auxiliary feature of these tunnels is the ventilation. The roadway section of the third bore will be ventilated wtih one-half million cubic feet of fresh air per minute. Fresh air will be introduced at the portal building and blown down one side of the upper portion of the tunnel. Air in these ducts will be blown into the roadway section through openings at 15-foot centers in the ceiling of the roadway section. The exhaust gases will then be sucked out of the roadway section through openings in the ceiling into the exhaust duct on the opposite side of the upper portion of the tunnel. The exhaust gases will be carried to the portal buildings and blown vertically up through the roof.

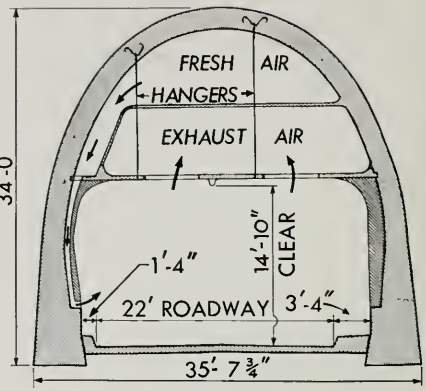
This method of ventilating, called the transverse system, is considered superior to the longitudinal system, used in shorter tunnels, in which air is introduced at one end of the roadway section and blown directly through the length of the tunnel. The old Broadway Tunnel bores also use the transverse system but the new type is less costly to construct and is expected to be at least as efficient, if not more so. In case of gasoline or other fires in the tunnel, the transverse system of ventilation confines the fire to one location, whereas the longitudinal system could create a blowtorch effect and undoubtedly cause considerable harm to vehicles and personnel in the tunnel.



GEOLOGIC SECTION ALONG NORTH TUNNEL



PROPOSED TUNNEL



EXISTING TUNNEL

Air Blowers Used

All of the ventilating of the new tunnel will be done from the new westerly portal building by means of two fresh air and two exhaust air blowers. The blowers are of the vane-axial type, seven-foot inside diameter and powered with 100 horsepower motors.

Continuous lines of fluorescent lights will be placed at each side of the roadway section throughout the entire length of the tunnel. In order to accustom the driver's eyes to the relatively small amount of light in the tunnel when entering from the bright sunlight, the transition sections of 300 feet at the ends of the tunnel will have extra tubes to give a varying brightness. The sides and top of the roadway section will be lined with light green-tinted tile to give a better reflective surface and facilitate cleaning.

Television cameras will be placed on the portal buildings to scan the entrances and exits of the three bores. By watching the incoming and outgoing traffic on the monitors within the control rooms of the portal buildings, the tunnel operator will be able to speed up the fans before heavy smoke-producing vehicles enter the tunnels. Experience in the existing tunnels has proved that better ventilation is maintained if the operator can speed up the fans before heavily loaded vehicles or a large group of vehicles enter the tunnel, rather than waiting for the instruments to detect the increase in carbon monoxide.

Safeguard Against Gases

Carbon monoxide gas is poisonous, odorless, colorless and tasteless. With the small concentrations of it normally found in tunnel exhaust gases, the average person would have to breathe it for a great number of hours before suffering any noticeable ill effects. On the other hand, smoke particles in the exhaust gases are not normally toxic but are visibly noticeable and cause irritation of the eyes and nose. A considerable amount of smoke causing physical discomfort does not necessarily indicate that a harmful amount of carbon monoxide is present. Detectors will make a continuous record of the amount of carbon monoxide in the exhaust air taken from the tunnels and, when the percentage reaches any specified amount, the fans will be sped up automatically.

It is anticipated that television cameras will be placed at critical positions throughout the lengths of the tunnels at some later date to provide better traffic control, ventilation and quicker detection of emergencies. The performance of television equipment which works at such low light levels is being improved so rapidly at the present time that it is not considered wise to contract for such equipment until all other work has been completed.

Fire extinguishers will be placed within the tunnel at 125 foot intervals. Fire alarm and telephone systems will be spaced at 250 foot intervals along the tunnel for emergency use. A standby generator will be installed to furnish a limited amount of emergency power during critical periods when the primary electrical source might fail. Service road bridges will be built over the roadways at the westerly portal so that maintenance and emergency vehicles can have access to any one of the tunnels without interfering with the fast moving traffic entering or emerging from the tunnels. The working conditions for the tunnel operators will be greatly improved over those now provided.

The new tunnel will be modern in every respect and will be a welcome facility to the daily commuters between Oakland and Contra Costa County.

Statisticians figure the Division of Architecture construction program will require more than 2,900,000 man days of labor by construction trades, plus more than 2,000,000 man days of labor to manufacture the construction items to be used.

Bay Bridge

First Phases of Reconstruction For Added Capacity Completed

By N. C. RAAB, Chief Projects Engineer, Division of San Francisco Bay Toll Crossings

The San Francisco-Oakland Bay Bridge was opened to vehicular traffic on November 12, 1936, and from that time to the present there has been an ever increasing volume crossing the structure. The daily average in 1937 was slightly less than 25,000 vehicles; today it is over 100,000.

On May 9, 1937, the first bus lines were started, which were followed by the interurban electric trains on January 15, 1939.

At the time the bridge railway was opened to the public, three lines utilized the rail facilities on the lower deck. They were the Interurban Electric, the Sacramento Northern, and the Key System. Although good, economical transportation was offered the public, the first two companies had to abandon their lines over the bridge within the following two years due to the lack of patronage. The Key System converted a portion of its passenger transportation operation to motor coaches, paralleling in some cases the service provided by the transbay electric trains. The change was primarily brought about to effect operating economies.

Patronage on the trains steadily declined from a maximum of 37,334,000 in 1945 to 6,113,000 in 1957 and as a result the Key System, in 1955, petitioned the Public Utilities Commission for permission to abandon its rail lines and inaugurate motor coach service. A ruling of the commission ordered this change, and on April 20, 1958, mass transit by motor coaches across the Bay Bridge became effective. The rails were no longer in use.

At the time the Key System was seeking relief from its train operation, the California Toll Bridge Authority, in its meeting of December 12, 1956, passed a motion with respect to the financing of any necessary reconstruction of the San Francisco-Oakland



An aerial showing the Transbay Transit Terminal (foreground) in downtown San Francisco with the bus loop connection to the Bay Bridge, and approach ramps from the Embarcadero and Bayshore Freeways.



A ground view of the front of the Transbay Transit Terminal.

Bay Bridge, anticipating the abandonment of rail service.

Legislature Votes Money

In order to provide for this emergency, legislation was enacted and money appropriated by Chapter 27, Statutes of 1957, for studies to be made as to the ways and means of converting the lower deck and the Transbay Transit Terminal, with approaches thereto, for exclusive use of vehicular traffic.

The report of the Division of San Francisco Bay Toll Crossings, dated March 1957, outlined a means of financing the $35,000,000 reconstruction over a four-year period; funds for which were to be obtained from Bay Bridge revenues. Subsequent legislation was enacted, Chapter 2316, Statutes of 1957, approving the plan of construction and method of financing.

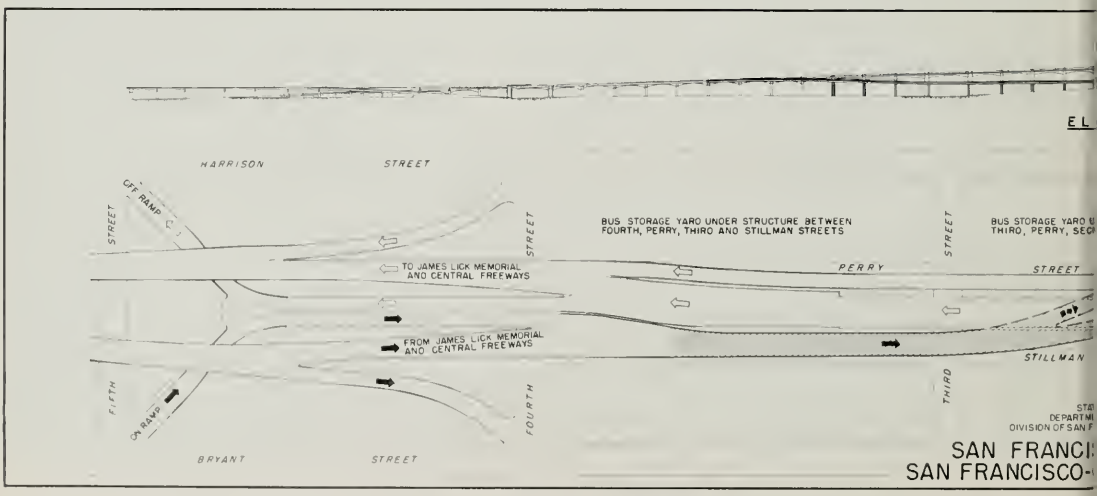
Prior to the start of any construction, it was necessary to evaluate the existing street, highway, and freeway conditions on both sides of the Bay, and proceed with construction in the area where the greatest relief could be obtained in the shortest time.

It was apparent, from existing conditions, that all construction should start on the west end of the crossing and proceed eastward. Contracts were then prepared requiring that all track and rail equipment be moved over the bridge railway and stock-piled in the East Bay Storage Yard, thereby eliminating any additional traffic on the lower deck truck and bus lanes caused by our construction equipment.

Transbay Transit Terminal

The redevelopment of the transportation system for transbay commuter traffic was immediately started by the State of California under its Department of Public Works after the last train crossed the bridge, on April 20, 1958. This, in general, consisted of removing the tracks; paving the vacated areas; and remodeling the Transbay Transit Terminal for the accommodation of bus service.

Besides the immediate emergency construction and changes required in the physical properties in and around the Terminal Building and on the bridge proper for the changeover from trains to busses without interruption of service, there was the long-range planning and construction re-



quired to alleviate the added traffic congestion resulting from the additional busses loading, unloading, and traversing the city streets of San Francisco.

This required the removal of all railway trackage and appurtenances from the bridgehead to the Terminal Building and paving the area. While construction was still in progress, three of the 14 bus lines were routed through the building six months after rail service ceased, or on October 19, 1958. All lines were operating from the terminal by July 12, 1959. On February 1, 1960, Western Greyhound Lines started operating 25 busses in and out of the building each day to the Lafayette, Walnut Creek, and Concord areas.

The Transbay Transit Terminal is a four-level structure, having a garage in the basement, waiting and concession areas on the first floor, passenger concourse with ticket offices on the mezzanine, and bus facilities on the upper level. The upper portion of the building is 700 by 164 feet in dimension and is built over both Fremont and First Streets in San Francisco.

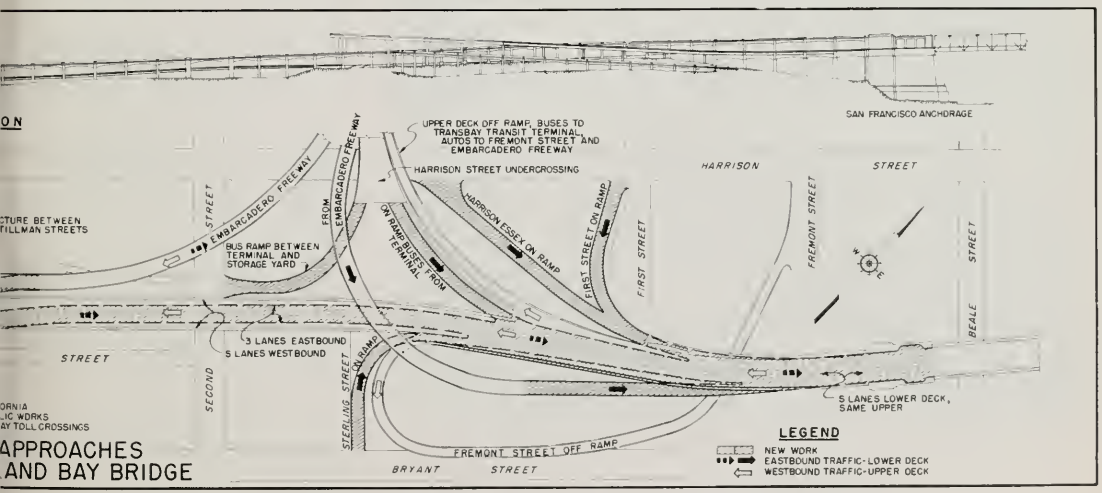


Passengers baard ane af the San Francisca-Oakland buses in the remadeled Transit Terminal.

Roadway Is Widened

Formerly, there were six tracks running through the terminal in pairs of two, separated by columns supporting the roof. Tracks were removed, the columns placed on the offside platforms, and the area paved, giving a roadway width of 25 feet which provides sufficient room for a moving bus to pass another at the curb.

There is a longitudinal movement of busses through the building and coach stops are spaced two bus lengths apart, 10 in each roadway, giving a total of 30 for the three roadways. A traffic treadle is located at each stop. The right front wheel of the coach, upon arriving, stops on the treadle, and the driver is notified as to his position by a telltale light on the left curb. At the same time the letter of the busline of the arriving coach is lighted on large indicator boards on the first floor and lobby by the depressed treadle under the coach. Passengers take the escalators or stairways to the mezzanine where smaller indicator signs direct them to the proper ramp or stairways leading to the loading platform. Directly over the bus,



there are lighted indicators giving the letter of the coachline.

In a total blackout, the indicator system is switched to a direct current line which will provide sufficient illumination to guide passengers to the proper busses.

At present, there are two bus companies using the terminal facilities, operating 690 coaches in and out each weekday with about one-half this number on Saturdays, Sundays, and holidays. On workdays, there are approximately 27,000 passengers transported each way.

Since cessation of train operation, there has been a slight increase in bus patronage, somewhat less than one percent over the same months of the previous year. There should be an even greater increase after the Transbay Transit Terminal and grounds are completely rehabilitated and the public becomes better acquainted with the services offered.

San Francisco Approaches

The reconstructed bridge will have five traffic lanes on the upper deck to San Francisco, with the same number running in the opposite direction on the lower deck. The choice of direction was determined by the amount of rearrangement needed to the existing roadway connections to the present structure. It was readily apparent that to effect a westbound movement of traffic on the upper level would require a minimum amount of reconstruction consisting of the partial removal and lowering of only one of the present ramps.

The lower deck of the bridge with its 31-foot, three-lane roadway, had but one connection in the City of San Francisco, located at the intersection of Essex and Harrison Streets. There are now six roadways leading to the lower deck, which include the James Lick Memorial Freeway and the Terminal bus loop. The number of lanes required for each of these ramps was determined from traffic counts. The traffic pattern as described herein will undoubtedly change somewhat after the project has been completed, and travel habits become established.

Generally speaking, about 48 percent of the eastbound traffic to the bridge is generated west of Second Street and uses the freeway as an approach. The new connecting ramp has four lanes between Fourth and Third Streets and three lanes from Third Street to the lower deck.

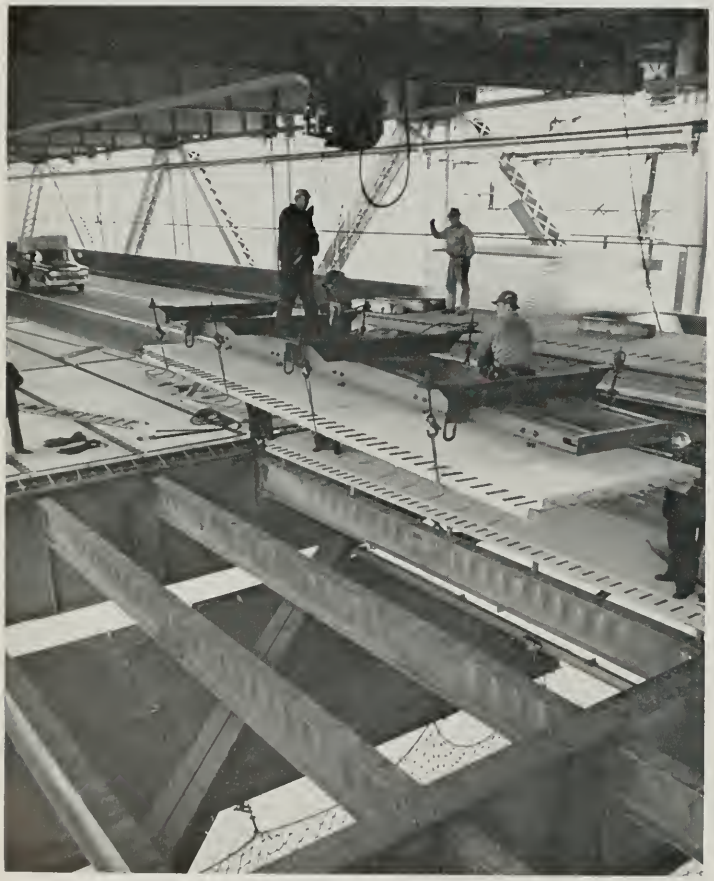
An emergency ramp using Sterling Street with a two-lane roadway under the upper deck was immediately constructed to relieve the Essex-Harrison Street connection during the peak hours between 4.30 and 6.00 p.m. when automobiles are allowed to use the lower level.

A permanent Sterling Street ramp has been completed, which will handle mainly truck traffic originating in the southern part of the city. This traffic has been estimated to be about two percent of the total eastbound peak load. It can serve as an emergency entrance to the bridge in case of tie-ups on the freeway.

The present Essex-Harrison ramp will handle only five percent of the evening peak when one-way operation is put into effect. This traffic will consist mainly of trucks and buses using Folsom and Essex Streets due to the better grades.

Ramp Has Free Lane

The new First Street connection is estimated to handle 20 percent of the afternoon peak hour load. Vehicles



Lower deck reconstruction on the San Francisco-Oakland Bay Bridge. A slab is swung into position across one of the lower deck bays by a special overhead crane. Some 1,400 of these precast concrete slabs, weighing up to nine tons, were used in paving the rail-bed area from San Francisco to Yerba Buena Island. (Photo by "This Earth" magazine.)

using this roadway along with the Essex-Harrison ramp will have a free lane leading onto the north side of the bridge.

The two bus lines using the Terminal Building for their San Francisco station have an evening peak of about two percent of the total eastbound traffic. There would be much less congestion on the lower deck during the afternoon rush hours if more commuters would use the public transportation provided. Buses average 22 persons per trip and closer to 40 during the rush, while the average for the private vehicle is a little less than two persons per trip.

The only ramp that required alteration in San Francisco to provide for the ultimate one-way traffic pattern derives its traffic from the Embarcadero Freeway and handles about 23 percent of the evening load. The major part of this traffic originates in the downtown area and uses the Beale-Mission Street entrance to the bridge. There is a clear lane on the south side of the crossing to accommodate this evening rush.

Another ramp on the San Francisco end of the bridge and not used for vehicular movement across the Bay is the two lane roadway from the Harrison Street undercrossing to Second Street and used by buses going to storage after their morning commuter run. In the latter part of the afternoon the parked buses are moved out of storage to pick up the evening load. The coaches are stored in two lots between Second and Fourth Streets and under the San Francisco approach.

Lower Deck Paving

The work involved in constructing two additional vehicular lanes on the lower deck to provide a 58-foot, five-lane roadway, consisted of removing the two tracks and appurtenant equipment; removing the railway stringer bracing which is no longer needed; removing and relocating the barrier which separated train and highway traffic to the south curb of the structure; and the placing of the precast paving slabs.

All removed material was transported via the bridge railway and into the East Bay Storage Yard where it is periodically sold by contract in lot amounts to the highest bidders.



A view of the completed five-lane lower deck roadway of the San Francisco-Oakland Bay Bridge.

The existing three lanes on the lower deck are required to handle the morning and evening peak hour traffic. The contractor performing the redecking work was not allowed the use of any of the three lanes between the hours of 4.30 p.m. and 8 a.m. This restriction and other details peculiar to the structure dictated the use of precast deck slabs which were transported to a section of the Bridge prepared for placing.

The slabs are a little less than 30 feet long by six feet wide and six inches thick. Four are placed transversely in a 30-foot panel and are supported by the four railway stringers, providing a paved width of 28 feet. Lightweight concrete, averaging 107 pounds per cubic foot, is placed in steel forms along with the steel truss reinforcing bars at the casting yard. After receiving their initial set they are steam cured until a strength of 2,000 pounds per square inch has been reached when they are then removed from the forms. A cycle of 24 hours is required for a set of slabs.

Crane is Suspended

The four slabs per panel are positioned by an air-operated traveling crane suspended from the upper deck floor system and are held in place and adjusted to proper elevations above the stringers by surface operated screw jacks. The two ends of the four slabs are brought to the proper elevation by measurements from straight edges. One end of the straight edge rests on the existing roadway slab while the other is placed at the grade elevation marked on the curb. Certain of the slab reinforcing bars are welded to the top flanges of the steel stringer, after which the jacks are removed; the sides are then formed and quick setting concrete is placed in the joint space around the lapped reinforcing steel projections to unite the slabs into a monolithic pavement.

The finished roadway deck is then striped for five lanes; the south lane is barricaded for contractor's operations, leaving four lanes for lower deck traffic, two in each direction, during the construction period.

Upper Deck—Concrete Approach

Probably the most exacting part of the reconstruction so far completed has been the strengthening of the present concrete upper deck approach to the bridge from Fourth to Sterling Streets. Also, the removing of the center columns of the three column bents



Looking east toward the lower deck approach of the Bay Bridge from the Bayshore Freeway.



A section of the lower deck of the Bay Bridge during reconstruction with the railway tracks removed.



Deck slabs in place ready for pouring of concrete into the joints.

supporting the upper deck from Sterling Street to the San Francisco anchorage.

The present upper deck roadway is 58 feet from curb to curb and is striped for six lanes of traffic, three in each direction. The upper deck floor system was not designed for heavy commercial vehicles.

All structural floor system members found deficient were strengthened by prestressing, as were the floor beams which had the center columns removed.

As all state-owned toll bridges carry property damage as well as use and occupancy insurance, and as the reconstruction was a deviation from the ordinary maintenance and repairs to the structure, the insurance brokers for the Toll Bridge Authority require an extra premium on the coverage during the construction period. They also stipulated that the time for the use and occupancy insurance to become effective be increased from 7 to 14 days.

Concrete Is Tested

Two checks were made to observe and verify the results of the stressing of the concrete member, which were by the retensioning of the strands to observe if they still retained their initial stress and the other, the running of precise levels over the upper deck benchmark before and after tensioning. Periodic measurements are to be taken over an extended period of time to observe any movement.

At the present time only a small amount of construction has been accomplished on the upper deck and only in those locations where work on the lower level required an upper deck revision. Several refuge bays were constructed and an acceleration lane for the present Fremont Street onramp to the upper deck was provided. When the project is completed, this structure becomes an offramp and the new widened length performs the function of a deceleration lane. This widening of the upper roadway and spreading of the columns supporting it provided the necessary roadway for the Sterling Street approach.

Bridge Traffic Capacity

Various individuals connected with highway planning and traffic have ex-



A view of the Tronsbay Tronsit Terminal and connecting loop viaduct looking eastward with the Bay Bridge in the background.

pressed some concern as to the estimated increase of from 25 to 35 percent in the traffic-carrying capacity of the bridge when completed for a unidirectional flow on each level. They have based their opinions on data contained in the "Highway Capacity Manual," Bureau of Public Roads, pertaining to streets, highways, freeways, and short structures.

They failed to recognize that this six-mile structure, with six lanes of restricted roadway, three in each direction, having few provisions for vehicular turnouts in case of emergencies, is not a freeway and a stalled vehicle must be immediately handled to maintain the roadway capacity.

Studies for the reconstruction of the Bay Bridge analyzed eight different lane channelization arrangements as to their traffic carrying capacities. The one selected for five unidirectional lanes on each deck was the only arrangement that more nearly satisfied the requirements of providing freeway standards with the maximum of safety and freedom of movement.

From the time the structure was opened to motor vehicles, on November 12, 1936, records indicate that there have been an average of 28 stalled vehicles per day, which has remained somewhat uniform, requiring the services of a tow truck or other maintenance equipment. An average of five stalls occur during the peak hours, one-half of which are in the lanes serving the major direction of traffic.

The Congestion Problem

In 1949 it took an average of 8 minutes (the equivalent of 75,000 vehicles per day) to clear the obstruction; however, in 1957 it took 13 minutes (95,000 vehicles per day). The longer time is presumably due to the greater degree of congestion, making it more difficult for emergency vehicles to reach the scene of the accident. Average recorded counts show that there is an average of 2,850 vehicles per hour passing a stalled vehicle in the two remaining lanes. During the peak hours, two free flowing lanes should have a capacity approaching 4,000 cars. A potential capacity of 2,000 vehicles per lane becomes more realistic with four passing lanes instead of two, resulting from a car stalled in the curb lane.

The bridge reconstruction program includes unidirectional travel on each deck, wider lanes, additional refuge bays, curb lane control signal system, and more frequent intervals between modern call and fire alarm boxes.

About 70 percent of the service calls are for minor causes, such as flat tires and empty fuel tanks. More refuge bays should reduce the number of stalled cars using traffic lanes awaiting emergency vehicles.

The wider lanes and signal control system will provide freer access for vehicles proceeding to the obstruction and more space to perform the necessary operations, thereby reducing the time to clear the lane.

With unidirectional traffic on each deck, the accident record of the bridge, although good, should be greatly improved. Head-on collisions, which result in the most fatalities, should be entirely eliminated.

The theoretical increase in traffic carrying capacity which would be provided by these improvements is 30 percent which could, under favorable conditions and with no breakdowns occurring, reach 35 percent, and could go as low as 25 percent under unfavorable conditions.

Maintenance Facilities

Accompanying the structural work required in the reconstruction are the installation of electrical and mechanical facilities that have been planned to provide a more effective and efficient maintenance and operation procedure.

There is now being installed water, electrical power, compressed air, and communication service across the bridge. It is also planned that the electrical energy, required in the operation of the facility, will be metered on both sides of the Bay with an automatic switch-over if failure occurs on either end.

Spotted at convenient intervals along the south truss of the structure are service platforms, access to which can be had from the lower deck or by ladders from the upper level. From these platforms the various connections can be made to the water, electrical power, compressed air or communication service needed. The latter system will be used by the maintenance crews. The tow car and fire alarm service will be connected to this multiple conductor cable from each level.

The water supply will be metered from Yerba Buena Island and flow by gravity to each end of the bridge. Water is provided for fire protection and for steam cleaning; however, the amount used is small.

The Sterling Street Substation, which was formerly used to transform and supply electrical energy to the trains when crossing the Bay, has been rearranged to receive and meter the energy from the power source, transform it to the proper voltages, and then feed to various outlets. Also located in this building are the electric driven air compressors used for maintenance cleaning, operating air tools, and fog horns. Stations similar to this will be located on Yerba Buena Island and at the east bridgehead.

The installation of these permanent maintenance facilities and the providing of additional movable platforms under the upper and lower decks, together with movable gantries along the outside of the trusses of the bridge, should keep all roadway lanes relatively free of maintenance vehicles.

Roadway Lighting

As the minimum clearance between the lower deck pavement and the floor system of the upper level has been maintained at 16 feet throughout the length of the bridge, it will require a somewhat unusual roadway lighting system to adequately supply a high level of illumination without the usual lamp glare and the alternate bright and dark spots on the roadway.

The lower deck with its 24 hour Yerba Buena Island tunnel lighting will offer another problem; however, if all the roadway lighting for the lower deck is properly located and constructed to give a high level light output, vehicular traffic should be able to negotiate the length at a somewhat higher average rate of speed with added safety.

These facilities, together with the wider, unidirectional roadway lanes, should provide a safer, freer, and possibly faster transit over the structure. The opening of the completed portion of the lower deck to four lanes has already demonstrated the greater comfort in driving on that section of the bridge.

(This article will be followed soon by another on the construction from Yerba Buena Island to the Toll Plaza in Oakland and for the revisions to the upper deck.)

Fair-bound Drivers Will Note Changes

The State Fair in Sacramento is a summer season highlight for thousands of Californians, and recent improvements on highways leading to the state capital will make this year's trip to the fair even more enjoyable than in the past.

The 1960 California State Fair and Exposition will be held August 31 through September 11. Fair officials predict the 1960 event will be the biggest and best ever with new entertainment features added to the usual long list of headliner attractions.

Motorists enroute to the fair will find that every main state highway leading to Sacramento has been improved to some extent in the past year, and new sections of freeway are open in several places.

Between the San Francisco Bay area and Sacramento, US 40 is all freeway and expressway, except two four-lane undivided sections north of Vallejo and on the Yolo Causeway.

New sections of freeway will be evident on this route at Richmond and in the vicinity of Davis. Freeway projects will be under construction near Fairfield.

Motorists who take the US 50-99 route from the Bay area to Sacramento will also encounter long stretches of continuous freeway and expressway. There have also been improvements on US Highways 40 and 50 in the mountains and foothills east of Sacramento.

Nearly 40 miles of new freeway have been opened between Sacramento and Nevada since State Fair time last year.

On US Highway 99E traffic is now using the new Yuba River Bridge at the south city limit of Marysville.

Reconstruction and widening on a section of Sign Route 24 in Sacramento County has been completed in the past year. Motorists will also notice that landscaping and planting work has been carried out on several freeway sections on routes leading to Sacramento.

Maintenance

Lighting, Landscaping Costs On Freeways Are Big Factors

By F. E. BAXTER, Maintenance Engineer

THE Federal-aid Highway Program of 1956 has focused attention on the nation's highways, and highway costs. This has also brought to the public's attention the problem of financing such a monumental undertaking, and of equal importance in this tremendous task of constructing the Interstate System of some 41,000 miles of multilane highway, is the problem of maintaining such a complex highway system.

The multilane highway of today, with its extensive rights-of-way; wide medians between opposing lanes of traffic; complex interchanges with on and off ramps; numerous dry land bridges for carrying cross traffic over or under the main arterial; wide shoulders; for all weather service to the motorist for emergency parking; multilanes of high type pavement to accommodate the heavy flow of traffic; extensive lighting and signing facilities at critical points to provide added safety to the motorist on these high speed multilane freeways, have increased maintenance costs accordingly.

This article is the text of a paper presented by the author before the Maintenance Operations Section at the Western Association of State Highway Officials Conference in June at Portland, Oregon.

Problems Not New

The problems encountered in maintaining multilane freeways are not new to the California Division of Highways Maintenance Engineers and field crews, for this change has been taken in stride over the past two decades, and assimilated as a part of our routine operation

The capital investment being placed in the Freeway System of Highways warrants a high standard of maintenance. The cost of maintaining a modern freeway has caused much discussion among maintenance engineers due to the increased cost of this highway, as compared to the old conventional two-lane road.



Cleaning a sign on the Harbor Freeway in Los Angeles. This late model sign has a catwalk for the use of maintenance personnel.



Another increasing function in freeway and expressway maintenance is the installation and repair of lights such as this one on US 50 east of Sacramento.

The following summary shows a comparative analysis of costs between a rural two-lane highway, a four-lane rural expressway, and a multilane freeway.

SUMMARY OF COSTS

Function	Two Lane Rural	Multilane Rural	Multilane Urban
A.D.T.	3,500-6,500	6,000-20,000	75,000±
1. Traveled way	69.1%	34.7%	13.0%
2. Roadside	22.1%	46.6%	62.0%
3. Signs	0.1%	5.8%	2.5%
4. Lights		4.8%	19.6%
5. Stripe	5.5%	3.7%	1.5%
6. Structures	3.2%	4.4%	1.4%
Total	100%	100%	100%

The two-lane study covered 155 miles located in four separate areas of California, where climatic conditions are comparable to those areas encountered on the multilane sections. Snow and slide removal are not factors in this analysis. The maintenance costs on the rural two-lane sections are the weighted average costs over the last five years ending June 30, 1959. The average costs on the multilane sections cover a three-year period ending June 30, 1959.

Traveled way maintenance costs on the two-lane highway consume 69.1 percent of the maintenance dollar, which is high when compared to the multilane sections. This is due to the fact that a majority of California's two-lane highways are over 25 years old and, in many cases, are old county roads that have been modernized over the years with an occasional base and resurface job.

The pavement widths vary from 18 to 22 feet, with no improved shoulders, except in isolated areas. Base and subbase on these old highways are not adequate to withstand the heavy loads that modern traffic imposes on them.

Considering the basic structural deficiencies of inadequate base and subbase, narrow pavement, and lack of improved shoulders, the net result is a high cost for traveled way.

Costs Can Be Traced

These costs can be traced to the following field operations. Base repairs are quite often due to poor drainage, or lack of base. Excessive shoulder maintenance due to dual tires on heavy trucks riding on pavement edge and displacing fines from the adjacent unimproved shoulder, thus requiring constant blading of the shoulder. Traveled way maintenance consists of "pothole" patching in inclement weather, and short ½-inch bituminous patches, crack-pouring on old P.C.C., and plantmixed surface pavement.

Added manpower for flagging is required in performing this work due to high speed and density of our traffic on these inadequate highways.

Traveled way costs on the multilane highways vary from 13 percent to 34.7 percent of the maintenance dollar. This is 50 percent less than the two-lane road, and due to the following facts.

Most of California's expressways and freeways have been constructed within the last 10 to 12 years. With emphasis on alignment, drainage, and structural section, the maintenance of this modern facility has changed from that used on the old two-lane highway of the early 20's or 30's.

Patrol maintenance is an essential phase of our operation. A traveled way free of "potholes," rough pavement, and an occasional box or some other obstruction, is necessary to prevent accidents. Street sweeping on curbed sections is a function not found on two-lane roads. Rough pavement repairs are usually corrected by placing bituminous plantmixed surfacing with motorgrader.

Additional Manpower Needed

The multilane highway with its high traffic density and speed, requires additional manpower for flagmen to protect the men who are working. This added phase of maintenance operations increases the costs in proportion to the actual work accomplished, but is essential to the safety of the motorist and the maintenance man.

Roadside maintenance of the two-lane highway, contains several functions; i.e., maintenance of native trees, and shrubs; firebreaks in national and state forests; control of noxious weeds adjacent to agricultural and other critical areas; and mowing of adjacent roadside. The right-of-way widths on the two-lane highways are quite narrow in comparison to the four-lane multilane highways and, consequently, require only 22.1 percent of the maintenance dollar. Roadside costs on the multilane highway range from 46.6 percent on the rural areas to 62 percent on the urban areas. Maintenance costs of planted areas for the first three years of the establishing period are approximately 35 percent to 40 percent of the initial capital outlay. Maintenance costs for the ensuing

years will average 25 percent of the capital outlay thereafter.

The care and maintenance of the multilane highway on the Freeway System with the large number of interchanges that are to be found in both the urban and rural areas, together with the wide right-of-way required on the Freeway System, run into large sums of money. We are then confronted with the care and maintenance of considerable increased width of roadside and median strips which are subject to noxious weed and fire hazard control, together with litter cleanup. Also included, will be planted areas for erosion control, screen planting for noise and sight abatements, or screen planting for headlight glare in the median strip. Some landscaping may also be included.

Cleanup Costs Increase

Litter cleanup and sweeping costs show a marked increase on freeways, because of the many additional curb miles to be swept and wide right-of-way to be cleared of rubbish.

Sign maintenance on the two-lane highway requires 0.1 percent of the maintenance dollar, while the rural expressway demands are 5.8 percent, and the urban freeway 2.5 percent, respectively.

Sign maintenance costs are low on the two-lane highways, due to use of standard signs that have been in use these many years. An occasional sign replacement and routine washing, account for the low cost of this maintenance.

Sign maintenance on the rural expressway shows a decided increase over the two-lane highway, and in percentage, the urban freeway appears lower than the expressway. This is misleading, due to the wide variation in total costs between the expressway and freeway.

On our modern Freeway System where high speed prevails, advance warning signs are a must. Illumination of these signs is a factor during inclement weather, and warns the motorist of approaching intersections, etc. The average number of signs on a typical cloverleaf interchange is 31 directional signs and 12 regulatory signs. This includes various signs approaching the intersection, as well as signs for 2-sign bridges, and all signs for on and off ramps. A standard intersection of two main highways at grade, would require 8 directional signs and 2 regulatory signs, or a total of 10 signs, as compared with some 43 signs for the same intersection on a Freeway System.

Factors Reflect Increase

The above factors, along with the substantial increase in size of the freeway signs, reflect the increase of sign maintenance of multilane highways over the two-lane highway.

The cost of lighting on the two-lane rural highway is, according to our records, very small, because we have very few installations.

Lighting costs on the rural expressway and urban freeway are 4.8 percent and 19.6 percent, respectively, of the maintenance dollar.

The increase in lighting of the multilane highway of today, over the two-lane road, is due to its interchanges, on and off ramps, and appurtenances, and requires complete illumination to keep traffic moving at an even pace to avoid congestion and to eliminate accidents.

In a recent study of the annual maintenance costs of signalized intersections, lighted signs, and safety lighting, it was determined as follows:

Traffic Signal Intersections

Annual costs vary from $680 to $890 per intersection, depending upon the complexity of the intersection; however, in a 12- to 15-head intersection, the average cost per head was $58.

Illuminated Signs

The annual cost of maintaining the electrical facilities of a lighted sign, including energy charges and replacement of lamps, was found to vary from $130 to $190 per sign, depending on its size.

Highway Lighting

The annual maintenance cost of a highway light was found to vary between $62 and $73.50. The main items included are energy costs and lamp replacements at two-year intervals.

The interchange, which is an integral unit of a full freeway, with its service connections, means a continued increase in this function of highway maintenance costs. As added multilane mileage is taken over for maintenance,



Work on heavily traveled highways is another problem that must be faced constantly by maintenance forces. Here a crew begins work on a section of the Bayshore Freeway in San Francisco.



Maintenance duties also include the upkeep of roadside planting. Here a maintenance truck waters young oleanders along the median strip of Sign Route 17 north of Los Gatos.

the increase in this important maintenance function will continue.

Traffic stripe and pavement markings on the two-lane highway require 5.5 percent of the maintenance dollar, and appear high when compared to the 3.7 percent and 1.5 percent of the maintenance dollar for the same function on rural and urban multilane highways respectively.

The differential in cost between the two-lane and multi-lane highway is due to stripe replacement. The narrow pavement lanes on the two-lane highway vary from 18′ to 22′ in width, and due to traffic density, causes much crossing back and forth over the centerline stripe, resulting in excessive wear and deterioration, whereas on multilane highways, with the heavy traffic volume, lane driving is the pattern, rather than weaving between lanes. Our records show that traffic stripe replacement on the Hollywood Freeway is required approximately every two years. While on the two-lane highway, restripping occurs every six to nine months and at least once a year. This is reflected in our costs records.

In summarizing safety devices, which include "signs," "lights," and "stripe," the rural two-lane highway costs 5.6 percent of the maintenance dollar, as compared to 14.3 percent and 23.6 for multi-lane rural and urban highways, respectively.

Maintenance cost on structures on two-lane roads requires 3.2 per cent of our total expenditures. This is not excessive when compared to 4.4 percent for multilane rural and 1.4 percent for urban freeways. The low cost factor for the urban freeways is due to the large number of relatively new structures that have, up to now, required a minimum of maintenance, as compared to the two-lane and multilane rural highways which have been in service much longer, with resultant increase in maintenance costs.

Maintenance Standards Are High

The large volume of high speed traffic that uses the expressways requires that the maintenance of the structures be of the highest caliber. The deck must be smooth riding and free from any skidding tendency, the drainage must function properly, the expansion details must be kept in good condition, and the approach roadway kept smooth and to the proper grade at all times. These items all require constant maintenance.

The volume and speed of traffic using freeways and expressways cause considerable maintenance in the way of repairing traffic damage. The majority of such damage is caused by vehicles striking the railing, or by structural members being hit by overheight loads. The maintenance costs resulting from such traffic damage are appreciable. Such damage must be repaired promptly both for safety and appearance.

There is but one inference to be drawn from this discussion—that maintenance costs on freeway systems are going to increase as the systems are completed. With the heavy traffic volume on these facilities, the maintenance cost per vehicle mile will compare favorably with the old two-lane road.

In conclusion, the problems presented in maintaining freeway-type highways do not vary greatly from those encountered in maintaining roads of other categories. However, they are multiplied by reason of having a much larger facility, and also by reason of providing a more complete service to the motorist. The traveling public will also expect a higher standard of maintenance on these highly publicized roads.

5/8c Gas Tax

Policies and Practices Governing State Funds for City Streets Explained

By M. H. WEST, City and Co-operative Projects Engineer, and
H. H. HOOVER, Senior Highway Engineer

THE TOTAL annual expenditure for street and highway purposes within the limits of California's 366 incorporated cities is approaching the half-billion-dollar mark.

In the 1958-59 fiscal year this expenditure amounted to $455,000,000, of which nearly one-half—$219,000,000—consisted of expenditures by the Division of Highways for the improvement and maintenance of state highways within cities. Most of this money was spent for rights-of-way and construction on new multilane freeways.

The accompanying "pie chart" shows the sources of the various funds from which expenditures were made by the State, the cities and others on city streets and highways. In terms of dollars for the 1958-59 fiscal year, here is where the money came from:

- As mentioned above, $219,000,000 from state and federal highway user taxes, for state highways within cities.
- From the State Highway Fund (⅝ cent per gallon of the gasoline tax, and other highway user taxes) $32,300,000 for construction on major city streets not on the state highway system and for maintenance and engineering.
- From other state funds, $6,700,000.
- From funds made available by other governmental agencies, $24,300,000 (including about $10,000,000 made available to cities by some counties as a re-subvention of their 1⅜-cent-per-gallon gasoline tax money).
- From various city sources, including sale of street bonds, street taxes, general fund, traffic safety fund, etc., $104,400,000.
- From private investments and improvement acts (such as in new subdivisions), $64,500,000.
- Carryover balance from preceding year, $3,400,000 (of which 72 percent was derived from State Highway Fund sources).

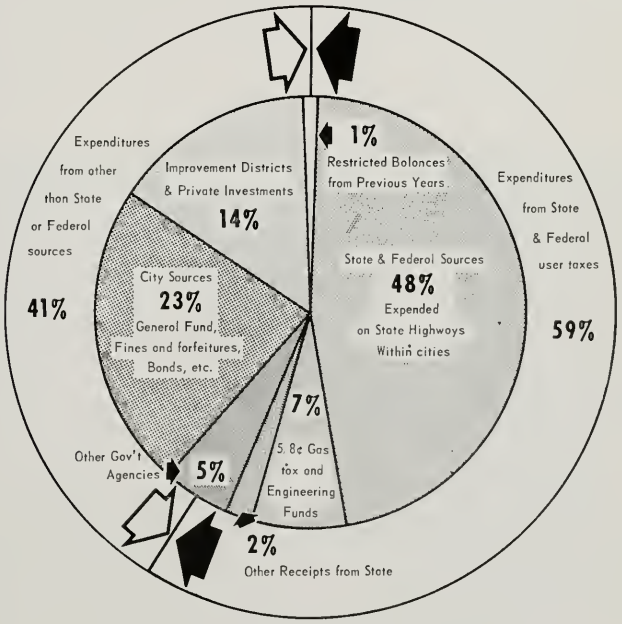
In addition, there was about $51,000,000 made available to cities in 1958-59 from the "in lieu" tax on motor vehicles which is collected by the State coincident with vehicle registration. However, only a small fraction of this money is used by the cities for street purposes, and is included in the $6,700,000 noted above.

Type of Service Is Key

The use of funds from several sources conforms to the general practice throughout the State of financing the cost of maintenance and improvement of certain classes of street and highway systems with certain kinds of tax levies. For example, it is the consensus in most quarters that the cost of street and highway improvements be assessed the taxpayer somewhat in accordance with the type of service afforded him by the particular street system.

Thus, the cost of the state highway system, which affords inter- and intra-city travel, is assessed in most part to the street and highway user who pays the gas tax. The major if not the full cost of the purely local roads whose sole function is to provide access to immediately adjacent land is assessed against the property owner. In between, the street and highway user *and* the property owners on a city-wide basis are assessed the cost of the community vehicular traffic service facilities, that is, streets of greatest general city importance.

It is upon this system of streets that the revenue from the ⅝-cent gas tax supplements citywide tax levies. Inasmuch as revenue from the ⅝-cent gas



Sources of funds expended for Street & Highway purposes within California cities 1958–1959 F.Y.





BEFORE AND AFTER—The photo (left) shows a section of Main Street (Sign Route 20) in Gross Valley before reconstruction. Photo (right) shows the street after the work was completed. This is an example of a co-operative project in which the city participated in improvement of a state highway, using ⅝-cent gas tax funds.

tax is a levy imposed upon the user, it is imperative that this revenue be expended so as to benefit the user to the maximum extent possible.

Legislative Controls—⅝-Cent Gas Tax Expenditures

Many questions have arisen concerning the controls and restrictions placed on the use and expenditure of ⅝-cent-per-gallon gas tax and the engineering subvention to the cities.

One of the questions asked most often is: "Why does the Division of Highways exercise considerable direction in the use and expenditure of these funds?"

Section 2107 of the Streets and Highways Code provides that "A sum equal to five-eighths of one cent ($0.00625) per gallon tax under the Motor Vehicle Fuel License Tax Law shall be transferred to the State Highway Fund for expenditure in cities as provided in Section 194." Under Section 195, it is provided that at least three-fifths of this sum shall be expended for construction of streets contained in the major city street system.

Section 2107.5 provides for annual payments to the cities from the State Highway Fund "for expenditure exclusively for engineering costs and administrative expenses in respect to city streets." These payments vary in nine steps from $1,000 for the smallest cities to $20,000 for the largest cities.

Sections 194 to 202 and 2050 to 2054 of the Streets and Highways Code provide that expenditure of gas tax funds be under the control and supervision of the State Department of Public Works. (The department has delegated this responsibility to the Division of Highways.)

Not 'Shared Revenue'

The State Attorney General on November 7, 1952, rendered an opinion that clarifies the department's obligations and responsibilities as follows:

"It seems to us that highway subventions do not belong to a political subdivision at all . . . It has been suggested that the gasoline tax money is



A photo of Huntington Drive in South Posadena after it was widened to six traffic lanes, two parking lanes and an 18-foot median strip.



Crenshaw Boulevard in Los Angeles was widened to six traffic lanes, with a 12-foot median and frontage streets on either side of the main roadway.

not a subvention, not a grant-in-aid; that it consists of funds which are centrally collected and locally shared for specific purposes, subject to state approval. The suggestion is self-defeating, because it calls into question the constitutional basis for the distribution of the revenue to cities . . . The constitutional basis for the imposition and distribution of gasoline taxes was that these were state revenues, imposed for state purposes and distributed in part to local governments, to be spent by them for state purposes only.

"The adoption of Article XXVI of the Constitution in 1938 did not change the nature of the gasoline tax. It still remained what it was in 1923—a state tax imposed for state purposes. Consequently, we must reject the suggestion that the money in the city's Special Gas Tax Street Improvement Fund is 'shared revenue.'

"The character of the money as state money is emphasized by the fact that it is not distributed directly to the cities. It is made available to the State Department of Public Works for expenditure in cities. The Streets and Highways Code indicates plainly that the city makes its expenditure as the delegee, or agent, of the Department of Public Works, only when the department has delegated the expenditure and only for projects approved by the department (Secs. 194-201)."

The ⅜-cent gas tax funds are State Highway Funds included in the State Highway Budget submitted annually by the department to the Governor. The prime responsibility for the expenditure of these funds rests, according to statute, in the department. Expenditures of such funds may be delegated to the governing body of a city *only* if and when the department is satisfied such city is "equipped to conduct the particular work to be delegated in an efficient and economic manner and if the city has set up by ordinance a 'Special Gas Tax Street Improvement Fund.'"

The statutes not only clearly establish the responsibility of the department in the administration and supervision of the 5/8-cent gas tax funds expenditures, they also set forth various restrictions on the use of such funds. These various restrictions may be separated into four principal subdivisions as follows:

1. **Prebudget requirements.**
 - **(a) Fund establishment.**
 - **(b) Selecting the major city street system.**
2. **Budget preparation and execution.**
3. **Preparation and approval of plans, specifications and estimates of cost.**
4. **Filing of annual and final reports.**

Prebudgeting

A newly incorporated city must establish a special gas tax street improvement fund and file certified copies of such ordinances establishing the fund with the department. This action is also necessary to qualify for payments under the Section 2107.5 engineering funds.

Before a city may budget any funds other than for maintenance, a major city street system must be selected by the city council and approved by the department as provided in Sections 2050 to 2054. Except for the City and County of San Francisco, no percentage or mileage limitation is prescribed for the major city street system. However, the legislative intent is clear in Section 2052: "The system of major city streets shall be selected by the city council on the basis of greatest general city importance subject to the approval of the department." Exclusions and inclusions necessary to update the system are provided for under Section 2053.

Public officials at all governmental levels have the responsibility of planning and providing for road, street, and highway improvements in a manner that will afford the public the best possible highway transportation service at the least cost.



Part of the work in widening Colfax Avenue in Grass Valley from 25 to 40 feet involved installation of this new culvert.



This photo shows a portion of 15th Street in Live Oak, Sutter County, after it was improved.

There is increasing recognition that a valuable aid in exercising this responsibility is a public policy expressed in a master plan which includes the traffic circulation element. The traffic circulation element generally includes state highways (freeways, expressways, or conventional high-type arterials), major arterials and collector streets.

A major city street system that generally conforms with or is included within the framework of an up-to-date circulation element of a city's master plan provides a city council with a sound basis for planning improvements with the use of 5/8-cent gas tax funds. In many rapidly growing cities, there is an increasing recognition and utilization of the advantages of this basis of planning. These cities realize that a static major street system cannot reflect changes in traffic patterns caused by changing land use and by other effects.

Budget Preparation and Execution

Section 197 of the statutes provides, "It shall be the duty of the legislative body of each city, on or before the first day of June of each year, to prepare and to submit to the department a budget on such forms as the department may specify, showing the estimated expenditure of such funds recommended to be made during the ensuing fiscal year."



One end of a widening project on Compton Boulevard in the City of Compton. Right-of-way is being purchased to continue the widening.



A view of the Aldine Drive Undercrossing now under construction on Fairmount Boulevard in San Diego.

Such budgets may provide for the expenditure of the total estimated apportionment or for a portion thereof for the fiscal year. In general, projects should be budgeted to the extent funds are available even though some improvements will necessarily be deferred until a later date when funds have been accumulated and are sufficient to accomplish the projects. Expenditures for maintenance are limited by statute to 40 percent of the annual gas tax funds and may include maintenance of both major and secondary city streets. A minimum of 60 percent of the gas tax funds shall be expended only for construction of streets included in the major city street system. Cities may, with department approval, limit maintenance expenditures to less than 40 percent of the funds in order to provide a greater portion for construction on the major city street system. Project statement forms are furnished to the cities to expedite the submission of the budgets.

The Department of Public Works by this same statute is authorized to disapprove any such budget or any item thereof if in the opinion of the department:

(a) The proposed work or expenditures do not comply with the requirements of the statutes as to the purposes for which such funds may be expended.

(b) If the proposed expenditures are excessive for the work to be done.

(c) If adequate provision has not been made to serve traffic on streets where previous expenditures of gas tax funds have been made.

Limited to Traffic Purposes

As to the purposes for which gas tax funds may be expended, Section 195 limits the expenditures to the portion of the street available for use by vehicular traffic, for pedestrian underpasses or pedestrian overhead crossings, installation and maintenance of traffic control devices including safety lighting, and the replacement of sidewalks and trees removed or damaged by construction. The code specifically excludes expenditures of such funds for these purposes: Street lighting, construction or maintenance of sidewalks (except as above) or the construction or maintenance of any facility in, over or under the street which is not of direct and primary service in providing a way for vehicular traffic.

Thus, the statutes clearly set forth the responsibility of the department to carefully check the proposed budgets as to purposes, to amounts, and to be certain that the expenditures are not scattered over many city streets without properly completing work started previously on other major city streets.

This usually is the first opportunity of the department to consider the work proposed by the city during the fiscal year. At this point, questions may be raised regarding the proposed structural and geometric sections.

How Wide Should It Be?

As a guide to these considerations, several authorities have set forth desirable street widths for various conditions. Excellent examples are included in "A Policy on Arterial High-



A view of Washington Street in San Diego after completion of a widening project.

ways in Urban Areas," American Association of State Highway Officials (AASHO), 1957; "Minimum Design Standards for Subdivisions" as adopted by the Public Works Officers Department of the California League of Cities; and "Engineering Standards and Instructions for County Road and City Street Deficiency Surveys," Joint Interim Committee on Transportation Problems of the California Legislature, September 26, 1956.

For a curbed two-lane major street with parking on both sides, these references recommend a minimum of 40 feet between the curb faces. This will provide 12-foot width travel lanes and 8-foot parking lanes. Likewise, a desirable minimum width for four-lane streets is 64 feet between the curb faces. The AASHO reference cited above gives desirable widths for medians, turning lanes and curb clearances.

In the case of streets located on side hills and in built-up areas where widening to meet these recommended street widths would prove too costly to be practicable, lesser widths are approved by the department if the city decides to prohibit parking on either one or both sides of such streets as necessary so as to provide clear travel lanes of 12-foot minimum width. In cases where attainment of the 12-foot lane width is considered impractical, a lesser width may be considered for approval.

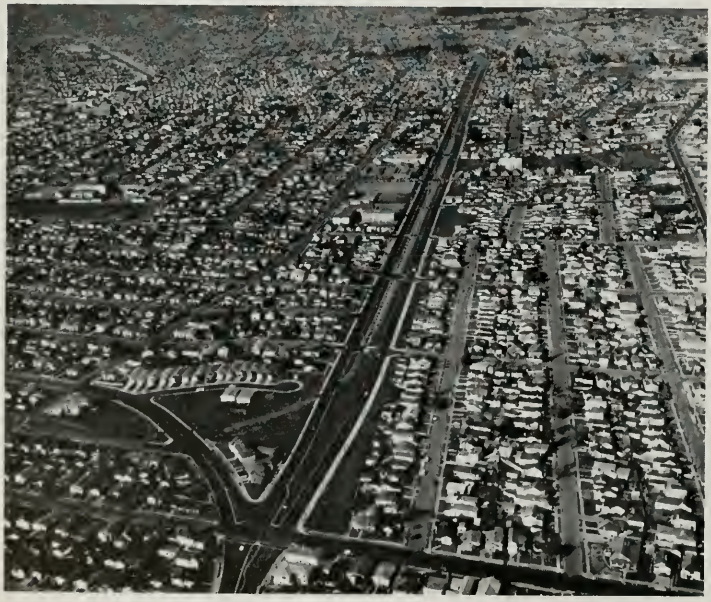
Parking Problem

All authorities agree that the practice of angle parking takes up a large percentage of the street width. Such parking materially reduces the ability of the street to efficiently handle moving traffic. Furthermore, the practice of angle parking creates greater hazards to moving traffic as well as to pedestrians in crosswalks. For obvious reasons, therefore, the department usually does not favorably consider street improvements with gas tax funds where the practice of angle parking is to be permitted after the street is improved. Where cities permit angle parking on city streets and consider such parking essential and of more importance than moving vehicular traffic, cities may of course finance the cost of the construction and improvement with other than gas tax funds.

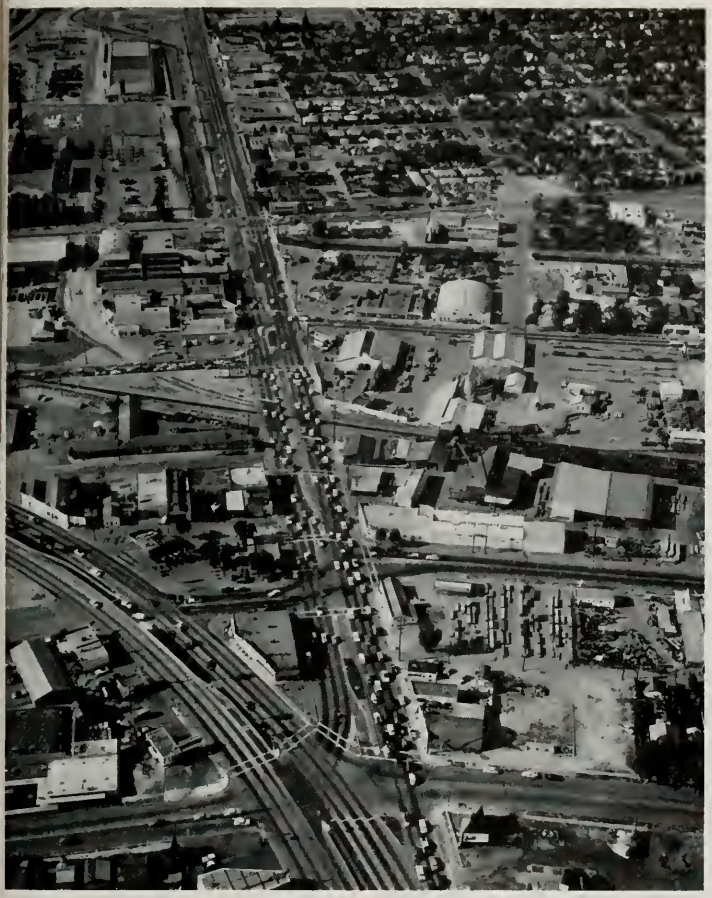
In many cases the objection to curb parking arises only during the peak hours, the volume during other parts of the day being insufficient to fully utilize all lanes. A logical and effective method for expediting such peak hour traffic flow is for the city to effect a restriction of curb parking, on one or both sides, to the extent that such parking be prohibited during peak hours. This results not only in extra traveled way width when most needed, but also in increased efficiency of operation. To some extent "no stopping" regulations also may be required, since the stopping of occasional vehicles produces various interferences when all through lanes are being used. The use of parking controls is a major item in the conversion of a local street to an arterial facility to meet current highway needs, but the need for expanded traffic facilities for the future also should be kept in mind.

Although the design may not be fully developed during the budgeting period, it is good practice to consider the traffic needs and general design at this point, rather than to leave all such consideration until the detailed plans and specifications have been submitted by the cities. Any serious discrepancy between this proposed design and the final plans and specifications may cause delay in the final approval.

The memorandums of agreement as prepared by the department, executed first by the city and then by the department, constitute approval of the budget and provide the basis on which quarterly payments may be made to that city. Although the revenue received by the department from the Highway Users Tax Fund is apportioned to the cities quarterly, payments may be made only to those cities which have an approved budget, and such payments shall not exceed the total amounts budgeted at that time by such cities. Payments from previously accumulated funds are made in addition to the quarterly apportionments when covered by approved budgets. Where payments cannot be made to a city due to insufficient budgeting, such funds ac-



This aerial shows the completed widening and reconstruction of Bancroft Avenue in Oakland.



This aerial shows Union Avenue in Bakersfield after it was widened. The highway joining Union Avenue from the left foreground is US 99.

cumulate in the State Highway Fund to the credit of that city.

Plans, Specifications and Estimates

As required by Section 199 of the Streets and Highways Code, the city must furnish to the department for approval adequate plans, specifications and estimates of cost for the proposed street improvement before expending any gas tax funds for construction. On gas tax projects, the city may not advertise for bids or perform work by day labor prior to the approval of the plans and specifications by the department. Nor may the city award any gas tax financed contract for an amount in excess of the engineer's estimate of cost or to other than the low bidder without first receiving the written consent of the department. Also, the amount of any item specified in the budget for maintenance or acquisition of any real property may not be exceeded prior to obtaining the written consent of the department.

The plans and specifications are thoroughly checked by department engineers experienced in urban street design to ensure conformance with legal requirements and principles of modern urban design, as well as for practicability and workability. The department acts as an advisory and regulatory agency to ensure compliance with the law and to verify that gas tax funds are being used to the greatest advantage for vehicular traffic.

In this phase of responsibility, the department renders a vital service to the cities by providing a final check which may occasionally uncover errors or omissions. Serious legal and financial difficulties to a city, as well as a reduction in the benefits, may result if these errors or omissions are not corrected.

The review includes a check on the structural design of the base and surface, as well as the geometrical features such as width, crown, curb height, and in some cases in city design—sight distance.

Bridge and drainage structures are checked structurally by experienced structural engineers to ensure that they meet the requirements for adequately carrying the design load. Traffic signals and safety lighting plans and specifications are checked by experienced traffic and electrical engineers.

The specifications are reviewed to ensure that they are comprehensive as well as sufficiently restrictive to provide a satisfactorily completed project; also to make certain that all necessary legal requirements are included therein.

Any obvious omissions or errors that are discovered in the review of the plans and specifications are called to the attention of the city engineer. Any differences of opinion regarding the design are discussed and a solution reached which is mutually satisfactory. Arbitrary attitudes by the department are avoided, as it is realized that city engineers are proficient in their field and are probably more aware of local conditions which may affect the proposed designs.

Annual and Final Reports

Section 201 requires of each city the filing of an annual report at such times as the department may designate, showing all expenditures made for maintenance in such detail as the department may require. All transactions within the cities concerning gas tax

. . . Continued on page 65



A genuine 20-mule team and borax wagons on US 395 near Lone Pine.



Cuesta Grade on US 101, San Luis Obispo County, as it looked in the late 1920's. Below: In 1940, as today, slides were a problem on the Palisades near Santa Monica. Below at right: A 1941 view of the eastern approach to Yosemite National Park via Tioga Pass.

THREE DECADES

For more than 30 years Merritt R. Nickerson, the Division of Highways' Supervising Photographer, has traveled up and down California photographing state highways. At the time of his retirement, it seems worthwhile to look again at some of the photographs he has made over these more than three decades.

When "Nick" first started taking pictures of California highways, the Model-T was the mainstay of automobile traffic in the state, and most of the highways were built for its slow speed, short turning radius, and

. . . Continued on page 56







Construction in the early 1940's on the access road to General Grant National Park.



1934 view of San Francisco and construction on the San Francisco-Oakland Bay Bridge taken from Yerba Buena Island.



Rebuilding US 50 over Myers Grade, 1940.



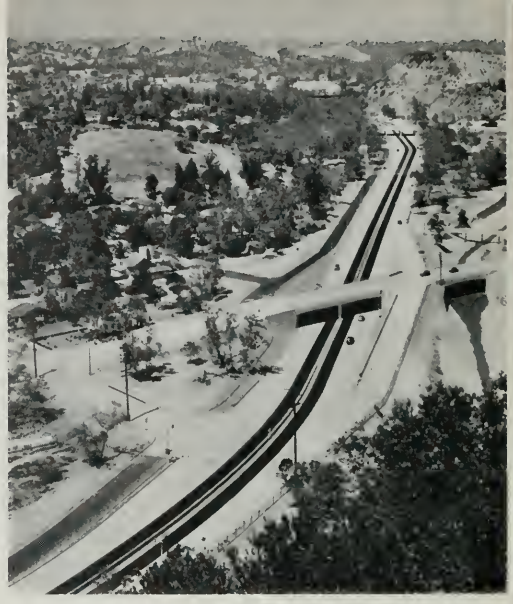
Above: Bixby Creek Bridge, State Sign Route 1, Monterey County.



At left: A falling boulder closes US 50.



The Feather River levee which brake at Yuba City in the disastraus 1955 flaads. State highway damage alone was more than $10,000,000.



First section of Pasadena Freeway (then called Arroya Seco Parkway), now part of the Los Angeles Freeway System. Completed in 1940, this was California's first freeway.



Study of 4-level interchange in Los Angeles when nearly completed. This photo impassible today as cars are constantly crassing camera viewpoint. Below: San Francisca freeway system, Bay Bridge, East Bay cities in background.



THREE DECADES

Continued from page 54 . . .

high clearance. Today California's highway engineers are world famous for their freeways.



M. R. NICKERSON

Nickerson was born in Nevada City in 1897, and now lives with his wife in Carmichael. He first worked for the state as a clerk in the Department of Education in 1915, but left this job to enlist in the Army in World War I.

After his return from overseas in 1919, "Nick" worked as a chainman and rodman on survey crews in the Dunsmuir area in District II, but in 1923 left the state to work for a Sacramento commercial photography studio. With this firm he began photographing highways on a contract basis a few years later, then returned to full time state service as a photographer with the Department of Public Works in 1932. More recently, Nickerson has confined his photography mainly to aerial.

US 40-Richmond

Final Section Completed From Jefferson Ave. to El Cerrito

By SPENCER F. ALLEN, Resident Engineer



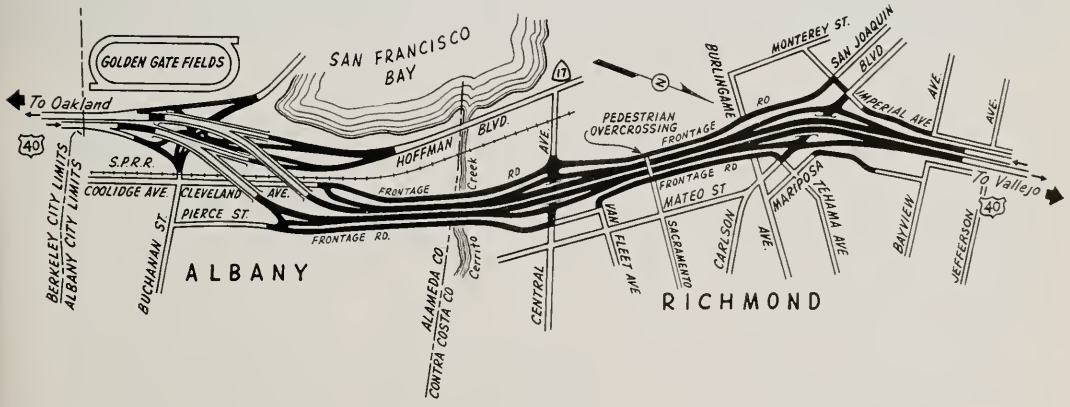
US 40 TRAFFIC has said goodbye to 2.5 miles of obsolete and inadequate undivided highway and gained full use of the final portion of US 40 in District IV to be improved to freeway standards. Mainline traffic began using the new freeway section on May 10, 1960.

This portion of six-lane freeway on US 40 completes a long-range highway project in District IV between the Distribution Structure at the east end of the San Francisco-Oakland Bay Bridge and Vallejo. The first of the eight contracts for this highway improvement was awarded in 1952 and the total construction costs for the facility will exceed 36½ million dollars, not including expenditures for the acquisition of right-of-way.

US 40 is the major interstate connection (Interstate Route 80) linking the San Francisco Bay area with points east and more directly with Sacramento and the North Valley regions. Except for this 2.5-mile section between Jefferson Avenue in Richmond and the El Cerrito Overhead, it has been possible, for some time, to drive from Sacramento to San Jose, stopping only at one signal in the vicinity of Fairfield, and at the Carquinez Bridge to pay toll. The final 2.5-mile section of highway is of particular interest to local commute traffic since there have been full freeway facilities at each end of the project since early 1957.



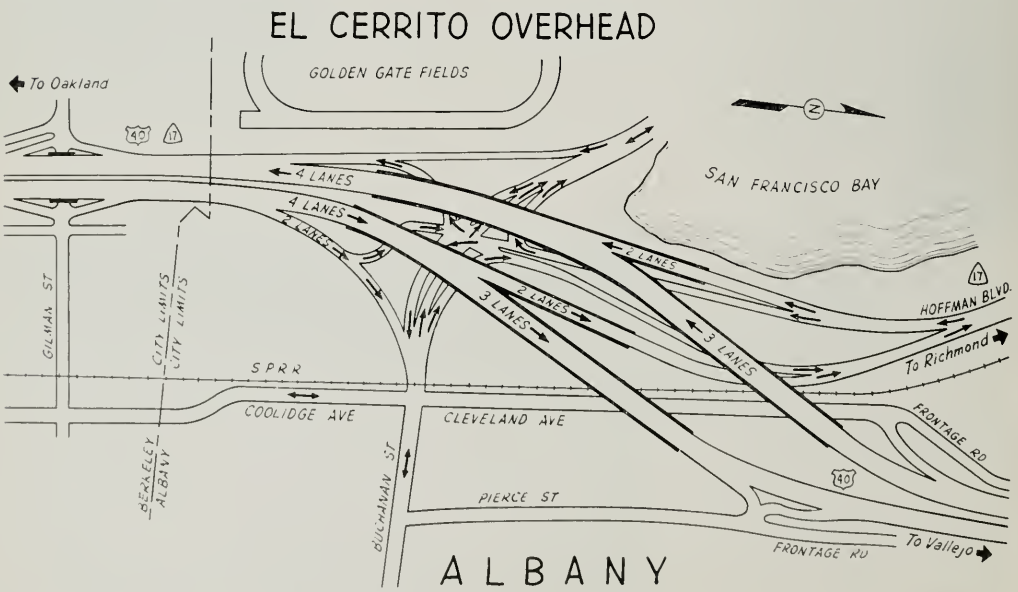
This photo taken during the final phases of construction shows the offramp at Carlson Boulevard for southbound traffic.



FINAL LINK U.S. 40 (EASTSHORE FREEWAY)



Provision was made to handle Eastshore Freeway traffic while construction on the El Cerrito overhead was underway. The view is southwest.



The arrows on this diagram of the new El Cerrito overhead show the direction of traffic flow on the main roadways and ramps.



Looking northward at canstruction of the El Cerrita overhead shawing tree-covered Albony Hill and (lower left) a portion af the racetrack at Golden Gate Fields.

Traffic Problems Created

The rapid growth of the Bay area and its spread to the outlying areas have created prodigious transportation problems. The commuter and the long-distance traffic have combined to result in a 30 percent increase since the annual traffic counts in 1954. The merging of US 40 with State Sign Route 17 on the structures at the south end of the project and the periodic invasion of fans to the adjacent Golden Gate Fields racetrack further complicates the traffic situation in this densely populated area.

The new improvement replaces the old four-lane undivided highway which was constructed in 1936 in time for the opening of the San Francisco-Oakland Bay Bridge. Subsequent channelization and signal installations at Central Avenue and Carlson Boulevard helped for a while, but became inadequate for the traffic needs during the past several years.

The contract was awarded on April 8, 1959, to the joint venture consisting of Piombo Construction Co., M & K Corporation and Connolly-Pacific Co., at a contract item cost of $5,169,810. The project has been administered by Piombo Construction Company which has its offices in San Carlos.

No Other Routes Available

As is usually the case where highway improvements are being made in built-up urban areas, there were no alternate routes available to accommodate the passage of traffic around contruction. Consequently, the project was designed using the original alignment and was divided into six stages of construction, in order to present as little inconvenience as possible to the traveling public.

The work consisted of constructing a six-lane concrete roadway; frontage roads and street connections; structure ramps; extensive sewer and storm drainage systems, and four structures.

Included in the work was an item for predredging the lagoons in the vicinity of the El Cerrito Overhead. Subsequent to the predredging, a 40-foot fill was placed over the exposed hardpan in preparation for the bridge abutments and roadway approaches. Underground work was complicated by the general slope of the area across the freeway proper, causing some storm drains and sewer installations to be placed in four separate operations as a function of the stage construction. Obviously, considerable effort went into maintaining the old systems through two winter seasons until the final connections could be accomplished.



A photo taken under a new portion of the El Cerrito overhead and interchange showing the tee-beam construction



A side view of the same tee-beam bridge shown in the photo above.

Costs Are Compared

Comparison of right-of-way costs versus construction costs resulted in the inclusion of nine retaining walls representing 1,800 cubic yards of concrete. The 476-foot retaining wall adjacent to the Southern Pacific railroad tracks was completely covered by imported borrow in Stage 1 in the summer of 1958 in the process of detour construction and was not exposed until Stage VI in the summer of 1960. Concrete paving for the through lanes was used except at one location south of Central Avenue where the roadways pass over Cerrito Creek. Soil tube borings in the area revealed the presence of mud to depths of forty feet. Consequently, a flexible type pavement was adopted for the portion of the construction in the vicinity of Cerrito Creek where the old roadway has had a history of excessive subsidence.

A large quantity of local borrow was necessary for embankment construction. Over 200,000 cubic yards of imported borrow was hauled a distance of six miles from future interchange developments at Hilltop Avenue in El Sobrante, and 70,000 cubic yards was hauled from stockpiles placed by preceding contracts adjacent to the project. The nature of the staging necessary on the project divided the concrete pavement operation into four separate stages. The contractor felt that the number of equipment moves on and off the project for this paving operation justified using a central mixing plant and transit mix trucks to deliver the premixed concrete to the project.

Structures Are Described

The bridgework consisted of the construction of three major structures,

a pedestrian overcrossing, and the revision of an existing bridge to accommodate realignment and access ramps. The new structure at the US 40-State Sign Route 17 merge at El Cerrito consists of a tee-beam reinforced concrete and structural steel bridge across the Southern Pacific railroad tracks, 2,122 feet long and providing a 40-foot roadway. The south end widens to four lanes for the two-lane onramp from Sign Route 17. The widest portion of the structure at the merge is 17 feet between curbs.

The existing structure has been widened at the north end to improve substandard alignment and to provide access ramps for City of Albany traffic. The south end has been widened for the State Sign Route 17 offramp to Richmond and the Richmond-San Rafael Bridge.

The Central Avenue undercrossing is a prestressed concrete girder bridge about 200 feet long. A two-inch minimum plant-mix surfacing blanket placed on the structure is integral with the plant-mix surfacing portion of the mainline roadwork in the vicinity of Cerrito Creek.

Pedestrian Crossing Built

The Carlson Boulevard undercrossing is a reinforced concrete box girder bridge about 131 feet long which provides a roadway width of 88 feet between curbs with an eight-foot median. In addition, a precast reinforced concrete girder pedestrian overcrossing about 184 feet long is constructed across the freeway proper at the Sacramento Avenue cut, which serves schools on the easterly side of the freeway.

Involved in the new and reconstructed structures are a total of 54 spans varying in length from 40 feet to 107 feet. Included also are two welded steel girders over the Southern Pacific railroad tracks and four rolled wide-flange steel beams matching the construction on the existing structure.

It is of considerable satisfaction to the Division of Highways, the Highway Patrol and the contractor to note that the accident frequency within the limits of the project has shown a constant decrease since the beginning of construction. Highway Patrol records show that formerly 25 percent of all recorded accidents on their 25-mile beat north from the San Francisco-Oakland Bay Bridge occurred within the limits of this 2.5-mile project. In the ensuing $1\frac{1}{2}$ years, in spite of stage construction and detours, the number of accidents within the project limits has been reduced to 8 percent of this total.

The author was resident engineer, acting under general supervision of G. L. Beckwith, District IV Construction Engineer.



An aerial looking southward along the new section of US 40 in Richmond toward the Eastshore Freeway. The Carlson Avenue interchange is in the foreground.

The California Highway Commission will hold public hearings in Southern California on October 27 and 28, 1960, on two freeway route locations. On October 27 the hearing will be held in the State Building in Los Angeles in connection with a routing for 5.7 miles of State Sign Route 134 in Glendale and Eagle Rock. On the following day the hearing will be in the Chino area, and will concern 13.5 miles of US 60 between State Sign Route 71 and Mira Loma.

NEW 'PER AXLE' TOLLS SPEED BRIDGE TRUCK TRAFFIC



This photo, taken before the new "per axle" tolls went into effect, shows truck traffic backed up at the toll gates of the San Francisco-Oakland Bay Bridge waiting to be weighed.

Truck movement over the San Francisco-Oakland Bay Bridge has visibly improved since May 1, 1960, when toll collection was changed from a tonnage basis to a flat charge per axle, according to State Highway Engineer J. C. Womack.

"Traffic flow has been so improved that we have received numerous favorable comments in the two months we have been operating under the new system," Womack commented.

The change was instituted following authorization by the California Toll Bridge Authority at its April 1 meeting.

Delays on the bridge are now rare and should be almost completely eliminated when the reconstruction work on the bridge itself and on the south side of the toll plaza approach is completed. Work on the toll plaza entails changing all collection lanes so that toll may be collected only from the driver's side.

Contributing to the smoother flow of truck traffic is the simple toll charge which is in 25-cent increments, thereby allowing the driver to know in advance the exact change to have available.

Since trucks are no longer weighed, there is no need to use special lanes, and trucks may mix with other traffic for passage through the toll plaza. The former time-consuming positioning on the scales having been completely eliminated. Spacing between trucks is approximately comparable to that between private passenger vehicles.



A photo of the Bay Bridge toll gate area taken after the "per axle" tolls went into effect. Note the great decrease in the backed-up truck traffic.

Asst. Comptroller Bert Sellier Leaves

Bert Sellier, assistant comptroller of the Department of Public Works for nearly 15 years, retired on August 1 after 32 years of state service, all of it with the department.



BERT SELLIER

Born in Foresthill, Placer County, July 28, 1895, Sellier attended the University Farm School at Davis and the Chaffey School of Agriculture at Ontario, engaged in farm work, and served in World War I with the 159th Infantry (40th Division). He was employed temporarily as a clerk in the accounting section of the Division of Highways in 1924, but did not receive a permanent appointment until 1928, when he became a senior clerk.

He advanced through the accounting ranks and was appointed assistant comptroller in 1945.

In this position Sellier assisted in all phases of the administration of the accounting operations of the Division of Highways, currently involving receipts and expenditures of more than $600,000,000 a year. He was closely identified with the preparation of district and field office accounting manuals, and the preparation of instructions regarding budgetary, cost accounting and related procedures, and provided considerable guidance for the various district chief clerks.

His areas of direct responsibility have included the disbursing office, the internal audit section and the headquarters accounting office, including the section which processes the vouchers for federal aid reimbursement.

Sellier and his wife, the former Salome Eleanor DeWitt, have a son, William E. Sellier of Palo Alto, and two grandsons.

Personnel Management

Governor's Policy Emphasizes Effective Use Of Human Resources in Carrying On State Work

The attainment of a sound and progressive personnel management program requires the co-ordinated efforts of the chief executive, of agency management, of central staff agencies, and of all other individuals and groups charged with the management of state government. It calls for the co-ordination of prescribed constitutional and statutory personnel management responsibilities with the basic responsibility of agency management for the effective use and development of agency manpower.

EDITOR'S NOTE

The personnel management policy statement adopted by Governar Edmund G. Brown for all state agencies is published here in full as a matter of interest and information to all officials and other citizens interested in the state highway program as well as to employees of the Department of Public Works. State Highway Engineer J. C. Womack has called the policy statement to the particular attention of Division of Highways staff members who are engaged in any phase of management.

An effective statewide personnel management program requires:

1. A management in each agency that actively exercises its responsibility for personnel management and continuously evaluates its personnel management program against established standards.
2. Policies and programs that facilitate the selection, utilization and development of the people required to carry out the functions of state government.
3. Adherence to the merit principles that are expressed in the Constitution and statutes.
4. The provision of personnel management services by the State Personnel Board and their utilization by state agencies.
5. The maintenance of channels of communication to keep the Governor informed of personnel activities and problems.

EDMUND G. BROWN
GOVERNOR

State of California
GOVERNOR'S OFFICE
SACRAMENTO

April 15, 1960

Honorable Robert B. Bradford
Director of Public Works
Public Works Building
Sacramento 14, California

My dear Director:

One of the most important and complex tasks which you have, as a State department head, is the management of personnel. While we must make good use of our physical and financial resources, our use of human resources can have an even greater effect on the quality of service we give to the people of California.

It shall be my policy, as Governor of the State, to provide for those personnel programs which are necessary both to obtain and develop a competent, responsible work force and to use that work force effectively. The attached statement develops this policy more fully by defining the responsibility for personnel management in State service and by describing the major elements of a sound personnel management program.

I want you to know the importance I attach to personnel management in State service. It deserves your earnest and continuous attention because it is one of your primary responsibilities as a manager, and because it will promote and sustain an effective career service to carry out the functions of State government.

This policy statement should provide a broad framework within which you can develop and maintain a personnel management program appropriate to the needs of your department.

Sincerely

Edmund G. Brown

EDMUND G. BROWN, Governor

Enclosure

Responsibility for Personnel Management

I. *Management Responsibility.* The essential purpose of the management of each state agency is to organize, direct and motivate employees to the end that the agency's goals are attained. This necessitates the fulfillment of the basic respon-

sibilities of management, including the planning of programs and policies; the development of an organization structure and budget and fiscal controls; the assignment of responsibilities; the setting of work standards; and the direction and co-ordination of the work force. It also requires a personnel management program in each agency which contains the following essential elements:

A. *Planning.* Work planning, including the setting of job and performance standards, provides the essential foundation upon which the orderly planning of personnel needs can be based. Personnel planning should give consideration to immediate and long-range staffing requirements.

B. *Personnel Utilization.* Available manpower must be utilized with maximum effectiveness. Work should be assigned in keeping both with human needs and the highest level of employee skill; the relationship between the job and the person as it affects employee performance and growth should be recognized in planning work assignments. Full use must be made of technological advances as a supplement to available human talent.

C. *Servicewide Career Opportunities.* Full recognition should be given to the "one state service" concept by supporting such measures as servicewide career opportunities, interagency rotation, and liberalized transfer practices.

D. *Training.* A planned program is required to develop the employee knowledges and skills necessary to meet the needs of the agency and of state service, and to keep abreast of constant advances in science and technology. Particular attention must be given to developing the managerial talent necessary to cope with the increasingly complex functions of state government.

E. *Performance Appraisal.* All employees should be made aware of the extent to which their work meets performance standards for the job, and should be given special recognition when their performance substantially exceeds such standards.

F. *Employee Incentives.* Management should provide incentives and recognition for agency employees and should encourage employee participation in such interagency activities as the merit award and work improvement programs.

G. *Communications.* Effective systems of communications must be maintained to and from the employees of an agency, with other agencies, and with the Governor's office. Within an agency, this can be accomplished through meetings and conferences and by the effective use of supervisory bulletins, agency newsletters, and procedure manuals. Communications between state agencies can be further improved through organized interagency groups with common managerial and technical responsibilities and through training activities that cross departmental lines. Communications with the Governor's office will continue to be maintained through the Governor's departmental secretary, and through participation in meetings of the Governor's Council, and the specialized committees which supplement the council.

H. *Grievance Process.* The grievances of employees should be discussed and resolved at the lowest possible level.

I. *Discipline.* Through effective supervision, high standards of employee conduct should be established and maintained. Disciplinary problems should be dealt with promptly and whenever possible they should be resolved without the need for formal action.

J. *Safety.* Continuous attention should be given to the improvement of working conditions as they relate to employee safety and to the development of safe working habits and attitudes.

K. *Inspection and Evaluation.* Overall reviews or audits of the personnel management program should be made periodically by each agency, making full use of the knowledge and experience of line supervisors.

Top management must provide overall leadership and followup in personnel management so that all concerned will be aware of the importance of that function to the successful achievement of agency goals.

II. *State Personnel Board Responsibility.* The State Personnel Board has the responsibility for maintaining a comprehensive merit system program and for assisting management in administering its personnel management program, consistent with merit principles. This requires that the Board:

A. Provide support and assistance to the agencies in carrying on effective personnel management programs.

B. Perform those personnel services best accomplished on a centralized basis.

C. Administer an equitable state salary program within the funds appropriated by the Legislature.

D. Facilitate the fair and uniform application of statewide personnel policies and standards in fulfilling its constitutional and statutory responsibilities.

E. Convey and exchange information on matters relating to the State's personnel program, provide information to the Legislature and remain responsive to the attitudes of the public and of employees and employee organizations.

F. Report to the Governor on activities, functions, proposals and developments as they relate to the State's personnel program.

GAS TAX

Continued from page 53 . . .

funds are audited by the State Controller's office.

Within 60 days after the completion by any city of a delegated gas tax financed project for real property acquisition or construction or improvement of any street, such city must file with the department a final report in such detail as the department may require. As provided in the Streets and Highways Code, quarterly payments of gas tax funds are withheld from any city which is delinquent in the filing of the reports required by the statutes.

The joint responsibility placed upon the cities and the State by the Streets and Highways Code requires wholehearted and harmonious relations between the officials of the cities and the department in order to obtain the greatest amount of benefit from the expenditure of the gas tax funds and to provide for the motorist maximum value for each tax dollar he pays. The state representatives endeavor at all times to work harmoniously with city officials.

Summary

1. Generally, the "rules" to be used with this subvention are as follows:
 (a) The Special Gas Tax Street Improvement Fund must be established.
 (b) A realistic major city street system should be selected by the city council on the basis of greatest general city importance, subject to the approval of the department. The proposed major city street system should be in accord with the city's master plan.

 The system should be reviewed for possible revisions at regular intervals.

2. In order to serve the planning function as well as the fiscal requirements, each city is required to submit a budget of the estimated expenditure of gas tax funds recommended to be made during the ensuing fiscal year. No payment of gas tax funds can be made to a city until its budget has been approved.

3. A maximum of 40 percent of the yearly allocation may be expended for maintenance. At least 60 per cent will be expended for construction or right-of-way on the major city street system.

4. At the time of the preparation of the budget, the general design is usually considered; however, the proposed geometric design should be in sufficient detail to determine its adequacy.

5. The statutes limit gas tax expenditures to that portion of the street available for use by vehicular traffic, with certain exceptions, and to structures in, over, or under the streets which are of direct and primary service for vehicular traffic.

6. Surveys, plans, specifications and estimates of cost must be submitted to and approved by the department before gas tax expenditures may be made for street construction or improvement.

The function of the department's review of the plans and specifications is to insure their legality, practicability, economy and conformance with accepted design principles. As street parking materially decreases capacity, impedes traffic flow and increases traffic hazards, consideration should be given to the restricting or prohibiting of curb parking where such practice restrict the safe and orderly movement of traffic.

7. Authority must be granted by the department before a city may advertise for contract or perform work by day labor.

8. Department approval must be received before a contract may be awarded by the city to other than the low bidder or to the low bidder if such bid exceeds the engineer's estimate.

9. Cities must file with the department annual and final reports covering expenditures of gas tax funds in such detail as the department may require.

10. Cities delinquent in the filing of annual or final reports are ineligible for quarterly payments of gas tax funds until such reports are filed.

Section 2107.5. Funds for Engineering Aid to Cities

Since its establishment by the 1955 Legislature, this subvention has been of considerable assistance to all cities, especially the smaller ones. The payment for the 1958-59 fiscal year under this subvention was $1,150,000. The obvious intent of this legislation was to furnish additional engineering services to the cities, not to replace other funds previously used. Thus, many smaller cities are able to provide for the first time the adequate engineering services, including advance planning, necessary to insure the economic expenditure of their construction funds.

In most California cities, the various available revenues are insufficient to finance the improvement of community service traffic facilities. Revenue from the much needed ⅛-cent gas tax has been provided by the legislation to help the cities finance the cost of improving the streets of greatest general city importance.

The services of the Division of Highways are available at all times to help in the formulation of street improvement programs and budgets so that the cities and their people may achieve the greatest possible benefit from use of the ⅛ cent gas tax funds.

BIDDING CAPACITY OF CONTRACTORS INCREASES

Although the number of contractors prequalified to bid on state highway projects decreased during the 1959-60 fiscal year, the bidding capacity of those listed increased. On June 30, 1959, there were 1,045 prequalified contractors with a combined bidding capacity of $2,115,174,500. On June 30, 1960, 987 contractors were prequalified with a combined bidding capacity of $2,363,226,000.

42 HIGHWAY PROJECTS ADVERTISED DURING JUNE

During June the Department of Public Works advertised for bids on 42 highway projects with an estimated value of $16,997,100. Since January 1, 1960, projects worth $235,260,300 have been advertised. Ninety-one contracts for $67,982,300 were awarded during June and 36 contracts for $21,448,000 were completed. At the end of June, 309 contracts were under way with a total value of $432,599,500, establishing a new all-time high.

Highway Commission Urges Advancing of Interstate Schedule

The California Highway Commission has gone formally on record in support of expediting the completion of the national system of interstate and defense highways under the established federal-state partnership.

At its meeting in San Diego on June 20, the commission unanimously adopted the following resolution:

WHEREAS, The 41,000-mile system of interstate and defense highways originally scheduled for completion in 1972 will provide great and needed service to the public and to interstate trade and commerce,

WHEREAS, This great public works program contributes so strongly to full employment and to general economic productivity throughout the country,

WHEREAS, Upon completion of this interstate and defense highway system, built to modern standards, highway accidents and highway fatalities throughout the system will be materially reduced,

WHEREAS, Federal-state partnership has been most productive in promoting the above benefits, and

WHEREAS, Since time is important in producing and even increasing these benefits to the people of all states,

NOW THEREFORE BE IT RESOLVED, That this system of interstate and defense highways shall be continued to completion and, because of the urgency of this program and the importance of its economic and social benefits, the time schedule shall be advanced to the maximum extent possible without departing radically from the present needs formula and without departing from the present federal-state partnership relationship.

Copies of the resolution have been sent to interested agencies and organizations, and to members of Congress and other legislators.

The resolution was adopted on motion of Commissioner James A. Guthrie, seconded by Commissioner Robert E. McClure.

Cost Index Takes 2d-Quarter Upturn

An expected upturn in the California Highway Construction Cost Index took place during the second quarter of 1960. Costs in this quarter began to reflect the actual increases in wages, materials and cost of financing which occurred during the last year. The index now stands at 251.6, an increase of 31.8 points or 14.5 percent over the first quarter of 1960.

A prime cause in raising the index to its present level was the increase in the unit price of roadway excavation. The determining factor for this increase was a bid price of $1.70 per cubic yard for roadway excavation on one US 40 project in a hard rock area of the Sierra Nevada Mountains. However, the index still would stand at 233.6 or 6.3 percent above that of the previous quarter if this project were to be eliminated from the cost index computation.

The number of bidders per project on all projects during the second quarter dropped from 7.5 to 5.8, while, on the 20 projects of over $1,000,000 each included in the second quarter's computations, the average number of bidders dropped from 10.5 to 6.5. Increases in costs had not previously become apparent in unit prices due to the keen competition among contractors, which had been more than sufficient to offset the upward pressures.

FREEWAY CONTRACT AWARDED

The State Department of Public Works has awarded a $3,806,235.40 contract to Peter Kiewit Sons' Co., San Francisco, for construction of 1.1 miles of eight-lane freeway on the MacArthur Freeway (US 50) between San Pablo Avenue and Broadway, Alameda County.

Included in the project is construction of nine traffic separation and ramp structures including bridges which will take the freeway over Webster Street, Telegraph Avenue, Grove Street, West Street and Market Street.

Judges Crack Down On Sign Vandalism

The courts in the San Joaquin Valley are taking an increasingly stern attitude towards persons who maliciously destroy traffic signs, judging from two recent incidents in which the boys who knocked down and damaged highway signs were given severe penalties, including jail sentences.

In Kings County, two 20-year-old youths were recently sentenced by Judge Walter W. Wilson of Hanford to 45 days in the county jail for knocking over with their car or pulling out 15 road signs on various roads between Lemoore and Hanford, including State Highway 198. They also were apprehended stealing hubcaps and part of the sentence was for that offense.

The signs they removed or damaged included a speed limit sign, five railroad crossing warning signs and nine stop signs, all important traffic safety devices, the absence of any one of which could cause a fatal accident.

Judge Wilson sentenced each youth to 225 days in jail on 15 counts of malicious mischief, with 210 days suspended on the condition that they pay an estimated $208 for the cost of the damaged signs. The signs were the property of the State, the County of Kings, the City of Hanford and the Southern Pacific Railroad Company.

In Fresno, Municipal Judge George W. Huffman recently imposed an even more severe penalty on three 18-year-old Fresno County youths who wrecked SCHOOL signs, STOP signs and YIELD signs at seven intersections and damaged seven mailboxes. Two of the youths received sentences of 120 days in jail, while the third was sentenced to 30 days.

In addition, each defendant was given a 180-day suspended sentence on each of three counts, placed on three years' probation, ordered to make restitution and had his driver's license suspended for two years. A fourth youth's case is still pending in the juvenile court.

The State Division of Highways has called for bids on a 13.3-mile freeway job on U.S. Highway 99 south of Bakersfield in Kern County.

'Tempus Fugit' Corner

Twenty-five years ago. The following items appeared in the July and August 1935 issues of *California Highways and Public Works.*

DRASTIC RESTRICTIONS

On June 3, $15,234,290 for work on roads and highways was apportioned to California out of the $4,800,000,000 Emergency Relief Apportionment Act of 1935. . . Federal regulations are so drastic that an entirely new type of construction procedure must be adopted if the federal money is to be used in highway construction. . . . Regulations received to date require a maximum of $1,400 per year per man for labor, materials, and incidentals (Division of Highways studies show cost per year per man is two and one-half to three times this limit); further, 90 percent of all labor employed must be taken from relief rolls in the vicinity of the work, which limits the amount of skilled labor that may be used, and projects must be selected from localities where relief labor is available.

Building Fill By Blast . . .

Engineers have saved the State $20,000 by moving granite ledge rock into Partington Canyon on the Carmel-San Simeon highway instead of building a bridge or culvert. Large pieces of rock blasted from the present road in 1923 formed a porous fill which permitted the peak runoff of the stream to pass through the interstices.

It was therefore conceived that with much more of this ledge rock available when excavating for the new road, it would be advisable to raise this present rockfill some 25 feet and place thereon the ordinary roadway embankment fill material.

The result was entirely successful. Some 25,000 cubic yards of ledge rock was blown loose, most of which was catapulted to position below. The balance, lying on the present road, was broken further and moved to position.

Commission Tours North, San Joaquin

The regular monthly meetings of the California Highway Commission for May and June were extended by two days and four days, respectively, in the form of inspection tours of state highways in northeastern California and the San Joaquin Valley.

"The commission feels these inspection trips are very educational," said Director of Public Works Robert B. Bradford, chairman of the commission. "We not only get a firsthand look at the routes on which planning and financing are under consideration, but we also benefit by personal visits with local officials and civic leaders who are in the best position to express the needs and desires of their communities."

After completing the regular agenda in Sacramento on May 25, the commission left for a trip to Plumas, Lassen and Modoc Counties. The trip covered portions of US 395, US Alternate 40, State Sign Route 89, State Sign Route 36, US 299, State Sign Route 139 and US 99E.

The commission met with local officials and community leaders at Portola, Quincy, Susanville, Alturas and Mineral.

Following its June meeting in Sacramento, the commission headed south on US 99 on the afternoon of June 24 for a seven-county tour of the San Joaquin Valley.

The commissioners stopped in Modesto, Merced and Madera during the afternoon for brief meetings with chamber of commerce groups and were guests of the Fresno County and City Chamber of Commerce at a dinner meeting in that city.

The Saturday schedule included stops in Firebaugh, Coalinga, lunch at the Lemoore Naval Air Station (Lemoore and Hanford Chambers of Commerce), Visalia, and Giant Forest in Sequoia National Park (dinner). Most of Sunday was devoted to a trip along State Sign Route 180 to Cedar Grove and other points of interest in the Kings River Canyon.

The tour ended on Monday in Bakersfield, after a midmorning stop in Porterville. The final event was a luncheon meeting with the Greater Bakersfield Chamber of Commerce.

Arrangements for the San Joaquin Valley tour were made by Chester H. Warlow of Fresno, vice chairman of the highway commission. The commissioners were accompanied by several members of the Division of Highways staff.

Stuart R. Davies

Stuart R. Davies, Supervising Electrical Engineer with the Division of Architecture died on June 23 from injuries suffered in an auto accident. Mrs. Davies, who was also injured in the accident, died on June 26.

Davies, 64, joined the division as a junior electrical draftsman on August 27, 1919. In 1923 he moved to Los Angeles where he worked for a year as an electrical engineer for the Allied Architects Association.

He then worked for several years with the Latourette-Fical Company in Sacramento and in the Bay area. During the depression era he worked for various contractors and architects doing electrical engineering work.

In August 1935 he returned to the division for six months during which time he performed the electrical work on the old Motor Vehicles Building and the Public Works Building.

Except for a short leave of absence prior to World War II, Davies was with the division continuously since May 1936. In 1938 he was appointed assistant electrical engineer.

It was at that time that he did the electrical plans for the Business and Professions Building. He made all the drawings, prepared the estimates and wrote the specifications.

He was appointed supervising mechanical and electrical engineer on December 1, 1949, recently retitled supervising electrical engineer.

Mr. and Mrs. Davies are survived by a daughter, Mrs. Eleanor Bryant of Sacramento, and two grandchildren.

Andrew Louargand, senior electrical engineer, has been named acting head of the Electrical Section, Sacramento office.

FOREIGN ENGINEERS STUDY DIVISION OPERATIONS



Part of the 40-man British team of municipal traffic engineers and representatives of the British Ministry of Transportation pause for a photo before taking off on a bus tour of Los Angeles freeways. District VII personnel who conducted the tour were (beginning extreme left) E. T. Telford, Assistant State Highway Engineer, A. L. Himelhach, District Engineer (Operations), Jack Eckhardt, Assistant District Engineer (Traffic), and George A. Hill, District Engineer (Planning).

Officials and engineers from Great Britain and the Philippines were among those who inspected and studied the construction activities of the Division of Highways during the past three months.

A 40-man team of municipal traffic engineers, officials and representatives of the British Ministry of Transport visited District VII headquarters in Los Angeles on May 3 as part of a two-week United States tour. The group was under the sponsorship of the British Cement and Concrete Association, London. The team was briefed by District VII engineers and taken on a tour of freeways in the Los Angeles area.

Felix C. Codilla, Staff Civil Engineer, for the Philippines Department of Public Works and Communications, was with the Division between November 5, 1959 and June 1 of this year. He spent most of his time in Los Angeles consulting with engineers on advance planning, traffic, design, construction, maintenance and equipment. He also conferred with the District IV staff in San Francisco.

During May Codilla visited the headquarters office in Sacramento where he consulted with engineers and Department of Public Works administrators on the statewide aspects of the highway program. He sat in on a Highway Commission meeting and discussed administrative problems with the other agencies of the department which included the Divisions of Architecture, Contracts and Rights of Way and San Francisco Bay Toll Crossings.



Deputy State Highway Engineer C. E. Waite (left) greets Felix C. Codilla, Staff Civil Engineer for the Philippines Department of Public Works and Communications during the latter's stay in Sacramento.

Supervising Agent Trenholm Retires

July 1, 1960, District VII Supervising Right-of-way Agent Kenneth Merrill Trenholm retired from state service, culminating a 15-year career with the Division of Highways.



K. M. TRENHOLM

Trenholm was born in Nova Scotia on March 14, 1904 and came to California in 1911. Following early schooling at Los Angeles Polytechnic High School, he began working at the Title Guarantee and Trust Company of Los Angeles in 1923 and held such positions as engineer, searcher, title examiner and unit officer. He joined the Title Insurance and Trust Company in December 1942 when the two companies merged. Later he became assistant manager of the Land Department of Pacific Western Oil Corporation. On July 1, 1945, he entered state service with the Los Angeles office of the Division of Highways.

One of Trenholm's first jobs with the Division's Right-of-way Department was the acquisition of properties for the Terminal Island Freeway. Since that time he has been engaged in extensive land purchases hand in hand with District VII's huge freeway building program. During the past 10 years, both as senior right of way agent and supervisor under Metropolitan District Right-of-Way Agent Harold Leonard, he and his present staff of 50 agents have been responsible for right-of-way expenditures amounting to between $50,000,000 and $75,000,000 annually.

Kenneth and his wife, Ruby Bickford Trenholm, a veteran employee of more than 32 years' service with various state agencies, reside in Arcadia. They have one son, Warren Kenneth Trenholm, of El Monte. Following their double retirement, the Trenholms plan to travel the United States in a trailer.

A. D. GRIFFIN RETIRES . . . WITH STATE 45 YEARS

When A. D. Griffin, Assistant District Engineer and Executive Assistant to Assistant State Highway Engineer Edward T. Telford of District VII, retired on August 1, 1960, he terminated a career with the Division of Highways that began more than four decades ago, in 1915.



A. D. GRIFFIN

His tenure of service spans the critical years of highway development in the State of California from the second $15,000,000 road-building bond issue of 1915 to the present pay-as-you-go highway budget amounting close to $600,000,000 annually. In his time, California's motor vehicle registration has soared from 163,795 in 1915 to 8,000,000 in 1960; state highway mileage from roughly 3,000 to 14,000; state population from 2,500,000 to more than 15,000,000.

A. D. Griffin was born in Attleboro, Massachusets in 1892 and came to California as a young man in 1910. In 1917 he graduated with the bachelor of arts degree in civil engineering from Stanford University after a brief period of employment with District VII of the State Division of Highways in 1915 (then Division VII of the California Highway included the counties of Los Angeles, Ventura, Orange, San Diego, and eastern Kern County south of Mojave). Subsequently he held positions in Division V at San Luis Obispo (1917-19), in Oregon with the Highway Commission (1919-21), and in California, again in District VII (1921 and thereafter).

Early in his career Griffin was resident engineer on a day-labor project at Point Mugu on the Pacific Coast Highway in Ventura County; the famed Hauser Contract in the vicinity of Big Sycamore Canyon, in 1923 the second largest roadbuilding project ever attempted in the State of California (see "The Spectacular Hauser Contract" by A. D. Griffin, *California Highways,* Oct. 1924); the Camarillo-Ventura Reconstruction Project (see "Some Interesting Problems Solved on Ventura County Reconstruction Project," by A. D. Griffin, *California Highways,* Sept. 1926); the Oxnard Coast Route (Oxnard to Hueneme Road), an experimental pavement project (see "Experimental Pavement Sections on Oxnard Route," by A. D. Griffin, *California Highways,* March 1927); and a paving job through the City of Laguna Beach (1927). Called in from the field in the latter year, he was assigned to direct charge of the district's plan preparation program for highway and freeway construction until 1947. From 1947 to date he has had general administrative duties, including responsibility for publicity and public information contacts.

He is particularly interested in the problem of "backlash" injuries resulting from rear-end collsions. He has studied the value of head and neck supports on the backs of automobile seats, and has made several experimental models for his own car.

Combining the rarely related talents of engineer and journalist, Griffin has been uniquely successful in translating the technicalities of highway engineering into clear expository prose. Periodicals ranging through the trade magazines, general circulation newspapers, technical and engineering journals, bulletins, brochures and pamphlets, press releases, and the *California Highways and Public Works* magazine, contain hundreds of articles authored or edited by Griffin. A representative few would be the following, from *California Highways and Public Works: Sidewalk 'Supers,'* May-June 1952; *Hollywood Freeway,* Sept.-Oct. 1954; *Proposed Arroyo Seco Parkway Extension to Los Angeles Business Center Through Elysian Park,* October 1940; *Major Construction Under Way on Coast Highway Through Malibu Ranch,* March 1938; *Opening of Newport Overhead Solves Bad Traffic Problem,* January 1937; *Newport Beach Grade Separation Plan Includes Two Bridges and Ramps,* February 1936; and *Hospital Chief Says Improved Highway Has Ended Accidents,* July-August 1933.

It is not surprising that Griffin's interests run to literature and books because of his writing background. He is a bibliophile and collector of incunabula, with his main interest lying in Californiana. Among his library of 2,000 volumes are several which he treasures above all the others. These are worthy of mention. General J. C. Fremont's *Memoirs,* 1887; Herbert Hoover's translation of Agricola's *De Re Metalica,* 1912, together with an original Latin edition of 1561; and a Latin-text Bible printed by Nicolaus Kesler, 1487.

With his retirement and the many leisure hours before him. A. D. Griffin will continue his current researches into safe driving, a subject he has written many articles on of late, and will do some free-lancing. With his wife, the former Bessie Ramsey, whom he married in 1919, he will maintain his two residences at 411 S. Westmoreland Avenue in Los Angeles, and 1863 Carmelita Street in Laguna Beach.

The Griffins have two sons, A. D. Griffin, Jr., and Bill Griffin, both engineers.

Associate Engineer J. C. Adams Retires

John C. Adams, Associate Highway Engineer with District V in San Luis Obispo, has retired after 31 years with the State.

Adams entered Civil Service in 1928 as an assistant resident engineer with the Division of Highways, District III, with headquarters in Sacramento. While there he worked on asphalt concrete projects in North Sacramento and at Clear Lake in Lake County.

He transferred to District V in 1929, became assistant highway engineer in 1930 and was appointed associate highway engineer in 1936.

Adams was resident engineer on the first four-lane divided highway in District V. This was known as the Montecito Parkway and extended between San Ysidro Road and Olive Mill Road on US 101 in Santa Barbara County.

Mr. Adams' main hobby is trout fishing which he intends to pursue actively after his retirement.

Division Announces Recent Retirements

Headquarters Office

Martin A. O'Brien, Highway Signing Supervisor, 26 yrs.

Katherine I. Reid, Delineator, 16 yrs.

District I

James A. Giacomini, Associate Highway Engineer, 6 yrs.

District II

Roy C. Cormick, Highway Engineering Technician, 11 yrs.

George Sanderson, Assistant Highway Engineer, 20 yrs.

District IV

LeRoy R. Cardwell, Carpenter I, 25 yrs.

Ira G. Pearsall, Highway Leadingman, 29 yrs.

Risto J. Spremo, Groundsman, 12 yrs.

District VI

Carl W. Hurlbut, Highway Foreman, 31 yrs.

District VII

Gerald Dowling, Senior Delineator, 31 yrs.

Edward Owens, Hwy. Equip. Oper. Lab., 27 yrs.

Peter V. Rodriguez, Laborer, 31 yrs.

Rafael L. Verdugo, Associate Right-of-Way Agent, 27 yrs.

District VIII

Hilton V. McDonald, Highway Foreman, 31 yrs.

Drury P. Wieman, Highway Foreman, 27 yrs.

District X

Merrill E. Jones, Laborer, 32 yrs.

District XI

Philip DiGruttola, Laborer, 15 yrs.

Adolphus E. Hopkins, Hwy. Equip. Oper. Lab., 30 yrs.

State-owned Toll Bridges

Alexander Robertson, Structural Steel Painter, 20 yrs.

Thomas R. Shannon, Structural Steel Painter, 20 yrs.

Headquarters Shop

Thomas F. Doud, Heavy Equipment Mechanic, 24 yrs.

PAINTING BRIDGES GREEN COMBINES BEAUTY, UTILITY

Many of the steel bridges on California's highways will soon be painted green to present a more pleasing appearance and to blend with natural colors of adjacent terrain and foliage.

This announcement was made by Governor Edmund G. Brown at his June 6 press conference on the basis of a report from Director of Public Works Robert B. Bradford. Bradford said the Division of Highways has adopted specifications for new green paints, which unlike previously used greens, will be durable enough for California's varied climate.

Frequent and costly repainting has been required with green paints used in the past, which is why they have been used so seldom, Bradford said.

"After extensive tests by our Bridge and Materials and Research Departments," he reported, "we have concluded that the new paints will be satisfactory from a cost and maintenance standpoint, and we are sure the new color will be an eye-pleasing change for both motorists and nearby residents.

"We are very pleased," he added, "to be able to combine beauty and utility in our bridge maintenance program."

In coastal regions, where bridges are subject to attack from salt-laden moisture, a new vinyl-type green paint will be used. In the interior of the State, steel bridges will be painted with a new green paint similar to that used in the past but with revised pigment components.

Nearly all of California's steel highway bridges are now painted with an aluminum paint which is a silver color.

The following nine bridges in widely separated areas of the state will be painted green this year under the regular bridge maintenance program:

The Noyo River Bridge on Sign Route 1 south of Fort Bragg, the Mad River Bridge on US 101 north of Arcata, the Salinas River Bridge on the Monterey-Salinas Highway near Hilltown, the Beaumont Overhead on US 60-70-99 near Beaumont, the Kaiser Road Overhead on the San Bernardino Freeway east of Colton, two Santa Ana River Bridges on Sign Route 38 near Redlands, and two Clear Creek Bridges on US 99 south of Redding.

Bradford said other bridges will be painted green in subsequent years as protective painting becomes necessary.

Most of the new bridges now on the drawing boards, or those on which improvements are planned, will also be given green finishing coats. Among these are the San Pedro-Terminal Island suspension bridge which will be Southern California's first toll bridge, and the Sacramento River Bridge on U.S. Highway 99 at Redding, which is being widened.

In addition to satisfactory durability characteristics and improved appearance qualities, the new paint offers advantages in the application process.

The only really satisfactory method of applying leafing aluminum paints is spraying, Bradford said. Spray application is difficult on heavily traveled highways or in major population centers, he explained, because of the danger of paint damage to vehicles and adjacent buildings and property. The new paints, however, can be applied by brush or roller as well as by spraying.

Commission Adopts Two Sierra Routings

The California Highway Commission at its July meeting in San Diego adopted freeway routings on two Sierra Nevada highways.

One adoption covers a 9½-mile relocation of the Carson Pass Highway (Sign Route 88) between 2.9 miles east of Picketts, Alpine County and the Nevada state line.

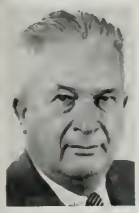
The other covers a new routing for 27 miles of the Sonora Pass Highway (Sign Route 108) in Tuolumne County between one mile east of Sonora and McCoy Saddle.

A public meeting on the Carson Pass routing was held by the Division of Highways at Markleeville in January; a similar meeting on the Sonora routing was held in March at Twain Harte.

District V Marks Dolliver Retirement

William S. Dolliver, City and Co-operative Projects Engineer for District V, San Luis Obispo, retired June 30 after nearly 33 years of service with the California Division of Highways.

Associate Highway Engineer Del Roberts, also of District V, has been promoted to the post vacated by Dolliver.



W. S. DOLLIVER

Born in Helena, Montana, Dolliver attended local grammar schools, spent two years at the University of Wisconsin and received his degree in agriculture from the University of Montana in 1917. He received a commission in the Coast Artillery Corps the same year and served with the A.E.F. until March of 1919.

Upon his return from France, Dolliver worked in Montana for the Bureau of Public Roads and the National Park Service on location and construction work, and various land appraisal and irrigation projects.



DEL ROBERTS

In 1923 he came to work for the California Division of Highways as a draftsman for a short time, and, except for two years spent with the Bureau of Public Roads, he has served with the division since 1925. He progressed from draftsman to locating engineer, resident engineer, to his present assignment as City and Co-operative Projects Engineer for District V.

The Dollivers have two sons, James and Roger. James received his Ph.D. from Cornell University this year and Roger is a first lieutenant in the U.S. Air Force.

Retirement plans for the Dollivers call for relaxation at their mountain retreat at Lake Coeur d' Alene in Idaho on their 160 acre ranch. Also on the agenda for the next few years are a trip through the United States and Mexico and a tour of Spain.

Roberts has worked in District V since 1953 as resident engineer on freeway construction projects and as supervisor of a freeway design section. He previously worked in the Surveys Department of District VII, Los Angeles, and had prior experience with the Colorado and Nevada State Highway Departments.

TWENTY-FIVE-YEAR AWARDS

Employees who received twenty-five-year awards since those listed in the May-June Edition of *California Highways and Public Works*

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District XI
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Albert U. Mullnix

Shop 11
Edward G. Schutt

DUMBARTON BRIDGE TOLLS COLLECTION IMPROVED

Another improvement in the collection of tolls has been put into effect at the Dumbarton Bridge. Heretofore tolls were collected from one small booth situated in the center of the roadway at the lift span. Now a temporary toll plaza with three toll booths has been constructed at the east approach so that two toll booths can be operated in one direction during peak periods.

Whenever a lift is made for navigation, the lift span operator notifies the toll plaza and all three toll booths are manned to take care of the subsequent surge of traffic. Response from commuters has been favorable.

ARCHITECTURE JOB TOTAL FOR YEAR $73,200,000

Construction projects authorized by the Division of Architecture during the 1959-60 fiscal year totaled $73,200,000, including $4,100,000 for which plans were developed by private architects. Approximately 2.7 percent of the above program was for day labor, including several large commitments for restoration of historical monuments. This small percentage of day-labor work is in line with the policy of maximum allocations to contract construction which was established several years ago. Also, during the 1959-60 fiscal year $88,300,000 of contracts were accepted by the director. These contracts involved change orders of less than $1,000,000 —percentage-wise less than 1.1 percent of the total.

Public school construction applications submitted to the Division of Architecture in June totaled $23,600,000, bringing the 1959-60 fiscal year total to $313,200,000, the second largest year recorded since the inception of the Field Act.

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1914

"ROLLER SKATING ON THE STATE HIGHWAY"

"Press dispatches report that 'skating rinks in San Mateo County are doomed to a natural death, judging from the avidity with which the young folk of the peninsula towns have taken up the fad of utilizing the new state highway for roller recreation. Moonlight skating parties are quite the common thing on the new smooth surface of El Camino Real. A party of young people from South San Francisco skated six miles to Easton one evening, built a big bonfire and served coffee and cake'."—from *California Highway Bulletin*, May, 1913.

Easton was incorporated into the City of Burlingame in 1916, so the skaters must have travelled over the section of paving in San Bruno shown in this 1914 picture. Highway surfaces in those days were better for roller skating, because the practice of deliberately roughening them to lessen skidding had not yet been adopted. Looking at the 1960 view of this same spot, skating obviously would be out of the question on this road today.

1960





NOV 3 1960

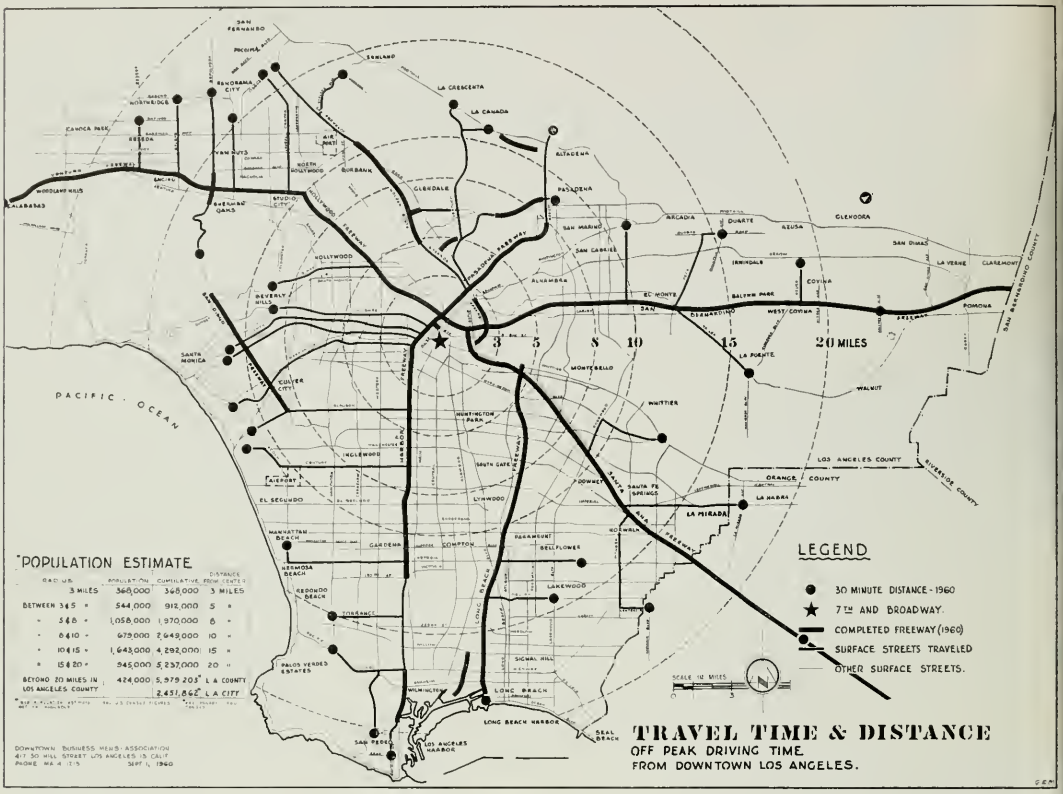
FILE IN STACK

CALIFORNIA Highways and Public Works



SEPTEMBER-OCTOBER
1960

NEW FREEWAYS SHORTEN PEAK-HOUR TRAVEL TIME



Freeways are shortening travel times despite steadily increasing vehicle registration in the Los Angeles Metropolitan area, a recent Automobile Club of Southern California travel time study reveals.

Although there has been an 11 percent increase in the number of vehicles in the area since 1957, it is somewhat easier to drive around now than it was three years ago, thanks largely to the addition of 47.5 miles of freeway to the system.

The five-day study, conducted by the auto club's engineering department in June, covered 342 miles of surface streets and freeways over 17 routes from various suburban areas to downtown Los Angeles. Test runs were made during morning and evening peak hours.

Overall average speed was found to be 26 miles per hour as against 24 m.p.h. when a similar test was made over substantially the same routes during June 1957.

Most striking gains in average speeds were recorded in areas served by the Ventura, Harbor and Long Beach freeways. One route utilizing 27 miles of the Ventura and Hollywood freeways permitted an average speed of 33 m.p.h. This compares with an average speed of only 22 m.p.h. over a comparable route in 1957.

Another route utilizing 19 miles on the Harbor Freeway and Figueroa Street permitted an average speed of 42 m.p.h. in 1960 as against 33 m.p.h. in 1957.

"In approximately 18 months to 2 years motorists can look forward to even more relief and still better travel time with the completion of the freeway loop bypassing the four-level interchange," points out John McDonald, auto club engineer. "The loop formed by the Golden State and Santa Monica freeways is now entirely under construction, with two links completed."

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California Highways and Public Works

Official Journal of the Division of Highways, Department of Public Works, State of California

Vol. 39 September-October Nos. 9-10



FRONT COVER—A downhill view of the new eight-lane freeway through historic Grapevine Canyon on US 99 south of Bakersfield. The black streak down the center of the northbound lanes is the result of a divider strip used during the final stages of construction when all traffic was placed on these lanes for a five-month period. In the center Grapevine Creek can be seen entering a section of the 9,000-foot-long concrete conduit constructed to offset excessive roadway excavation costs. On the right is a section of the old four-lane highway which is now serving as a utility bench, in which several large oil and gas lines were located. It is also used as a cattle trail and service road for the oil companies. (Story on page 5)

Photo by Jack Meyerpeter

BACK COVER—Looking northward over Folsom Lake State Park's Mormon Island unit situated on the south shore of the main lake. Earlier this year the Division of Highways supervised construction of the entrance road, kiosk, parking area and the launching ramp for the Division of Beaches and Parks. The remainder of the wooded point is equipped with picnic facilities. The vicinity retains the name of an island in the American River now submerged. At the bottom is Green Valley Road (Federal Aid Secondary Route 1096) which leads left to the dam, one mile; City of Folsom, three miles; right to Placerville, 20 miles. (Story on page 61)

Photo by M. R. Nickersan



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Hazelview Tunnel

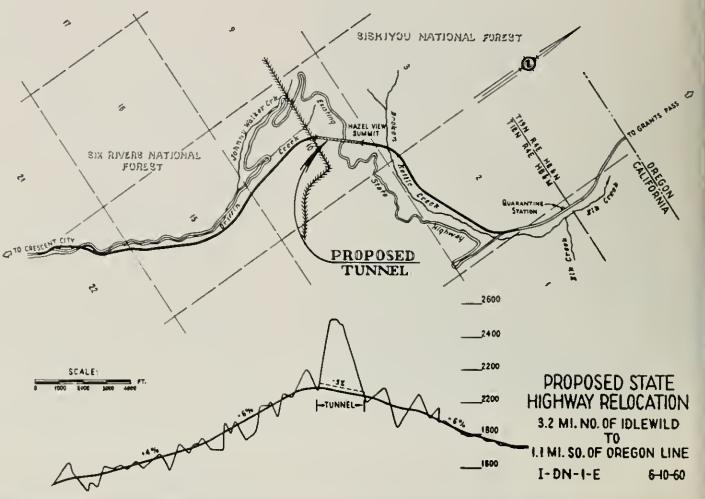
Groundbreaking Marks Start of US 199 Job

By L. R. REDDEN, Design Engineer



SIGNALING the start of a combined road and tunnel project, ground was broken, on July 8 near Hazelview Summit in Del Norte County, for a 4.3-mile unit of the Redwood Highway. Many state and local dignitaries from three states—Nevada, Oregon and California—took part in the ceremony. The actual "ground breaking" was performed atop the mountain through which the tunnel will pass.

To California's State Senator Randolph Collier went the honor of turning the first shovelful of symbolic dirt, assisted by Assemblyman Frank Belotti. The blade of the ceremonial





Some 500 people attended the groundbreaking ceremony which was preceded by an old-fashioned barbecue. The tunnel passes through the ridge about 450 feet directly below where the ceremony was held.



The existing State highway in the foreground crosses the ridge at the right center and descends to the south by way of the numerous hairpin turns that are partly visible. The North Portal of the tunnel has been superimposed on the photo.



The approach to the tunnel will lie on the precipitous eastern slope above Griffin Creek. The existing State highway reaches the summit through numerous hairpin turns or switchbacks located on the west canyon wall of the creek. Above and to the left of the superimposed South Portal, the cut bank at Hazelview Summit is visible on the present road.

shovel used by the Senator was made of chrome and nickel from Del Norte County, myrtlewood from Oregon and silver from Nevada. The symbolic dirt, a portion from each of the three states, was contained in an old Wells-Fargo express box that had made the trip between Crescent City and Grants Pass by stage coach over the pioneer roads of the 1870's.

Cavemen Participate

The Oregon Cavemen enlivened the celebration with a demonstration of how surveys were done in prehistoric times. The "transit" was a hollowed marrowbone supported on a forked stick; the "chain" was a series of marrowbones strung on a thong; and the level rod was a large piece of bark with a hole in it. It should be evident that the "accuracy" of the survey was somewhat less than 20th century requirements. Nevertheless, the cavemen were able, after much gesturing and unintelligible hollering, to finally locate where the ceremonial box of dirt should be placed—in front of the speaker's stand.

The project is located on US 199 between 35.3 and 42.4 miles northeast



In this view of the existing road, taken in the late 1920's, four legs of the switchbacks are visible (one leg barely visible in the lower right just left of the penned-in title). Note the line of wheelbarraws immediately ahead of the parked car apparently engaged in a ditch cleaning operation.



The north approach to the tunnel will be on the far side of the canyon near the bottom just above the logging road. The present road is visible on the hillside near the right center of the photo. The view is northeastward.



The new road will ascend from Broken Kettle Creek (foreground) up the side canyon and enter the tunnel approximately 150 feet above the creek bed and about 900 feet to the south. The fill across the creek valley will be about 110 feet high.

of Crescent City; the north end is just 1.1 miles south of the Oregon state line. Grants Pass, Oregon, on US 199, is 43 miles north of the state line.

The new facility will replace a highly inadequate section of highway, 7.1 miles long, characterized by narrow road, sharp curves (some 80- and 200-foot radius or less), switchbacks, difficult snow removal, and continuously steep grade. The south approach of the old road to the summit rises 950 feet in 4.1 miles.

The entire project is to be constructed in three separate contracts. The initial work, placed under contract during July, consists of grading the northerly 1.4-mile approach to the tunnel. The tunnel will be advertised for bids during the fall. It is hoped, subject to available financing, that grading of the south 2.5-mile approach, together with base and surfacing for the entire project, can be advertised early in 1961.

The facility is being designed as an initial two-lane road, with an additional lane for slow-moving traffic on steep upgrades. Additional graded width of roadbed is being provided to serve as a ravel catcher for all cut slopes 60 feet or more high.

Designed curvature is based on a 60-m.p.h. speed; and with the tunnel some 340 feet lower than the present road summit, the length of steep grade is reduced by some 2½ miles. The new facility will be 2.8 miles shorter than the present route of travel.

Has Warning System

The tunnel, 1,835 feet long, is to be 26 feet wide between curbs, with two-foot safety sidewalk or refuge areas on either side. It will be both lighted and ventilated, with telltale ventilation-warning installations.

Right-of-way for the approaches is being acquired for an ultimate four-lane facility and an additional tunnel.

The entire project is estimated to cost 7.4 millions, including about 3.9 millions for the tunnel. The initial contract, for the north approach, is held by Gibbons and Reed, who bid $446,400 for the 1.4-mile unit.

It is expected that the entire project will be completed by the fall of 1962.

Grapevine Grade

Historic Route Made Eight-lane Freeway

By NORMAN L. LAMBETH, Resident Engineer, and JOHN C. PUTZER, Senior Right-of-way Agent



Without ceremony, the most expensive and complex project in the history of District VI was opened to traffic on June 28, 1960. This project converted the old four-lane highway, with its concrete parabolic divider, to an ultramodern eight-lane divided freeway, winding up through narrow Grapevine Canyon, on US 99, between Bakersfield and Los Angeles.

The construction of the project was handled by the Guy F. Atkinson Company and was greatly complicated due to the fact that it was necessary, for a two-year period, to maintain passage for 9,700 passenger cars and 4,050 trucks on an average day. Construction was accomplished by doing the work in three major stages, so that it would be possible for four lanes of traffic to be available to the traveling public at all times.

The problem was worked out by constructing all possible uphill lanes on the westerly side of the canyon and tying them into the existing pavement so that all traffic was traveling on the westerly portion of the canyon. It was then possible to construct all of the northbound, or downhill lanes to completion. When the northbound lanes were completed, traffic was shifted to the easterly side of the canyon and the reconstruction of the remaining sections of the old highway was made possible to complete the project.

Precautions Taken

Before traffic was permitted to use the completed northbound lanes, every precaution was taken to make passage as safe as possible. One of the greatest hazards, for years, had been the problem of runaway trucks. To minimize this hazard, a temporary truck inspection area was constructed at the top of Grapevine Grade, near old Fort Tejon. This inspection area was manned 12 hours a day by the California Highway Patrol, between 1 p.m. and 1 a.m., the period of maximum truck volume through the canyon. Each truck was inspected for adequate brakes and other safety requirements.

Of major concern was the fact that there was no divider strip, and it was decided to narrow the lane widths slightly and paint two double stripes about four feet apart. Maintenance Superintendent William C. Bastian, who is in charge of the district's special crews, which includes traffic striping, made a suggestion that a half-



Looking narth through the canyon toward the San Jooquin volley. Portions of the Grapevine Creek conduit are visible between the lanes.



A temporary bridge was constructed over the highway for earth hauling purposes. Part of the old parabolic concrete divider can still be seen to the left of the road on the lower right part of the photo.



Looking north from the canyon toward the Grapevine Undercrossings. A portion of the old twisting 1914 road is visible on both sides of the northbound lanes of the new freeway.

inch blanket of plant mix surfacing be laid over the concrete in the divided portion, and that the two double lines be placed upon this. Upon completion of the project the plant mix surfacing could be easily scraped off thus eliminating the costly time-consuming job of sandblasting the paint off the concrete. It also provided a contrasting surface between the white concrete lanes and more effectively delineated the division.

After removal, the plant mix did leave a streak down the center of the northbound lanes, but this is not noticeable to motorists using this section of the highway. This stripe will probably wear off in a couple of years.

Several 'Firsts'

There were several construction features that were used for the first time in the district. Approximately 9,000 feet of blocked-out metal beam barrier railing was installed on both sides of the northbound roadway, where a tremendous fill, 107 feet high and containing one and a half million cubic yards of material, carries traffic to the valley floor. About 5,100 feet of cable chain link barrier fence was installed in the median strip in the upper end of the canyon where the roadways closely parallel each other. Both of these barriers resulted from extensive tests conducted by the Division of Highways Materials and Research Department. These crash tests were covered in a previous issue of this magazine.

The continuous 6 percent upgrade and almost continuous curves with superelevations between 4 percent and 8 percent created conditions far from ideal for concrete paving operations. The grade limited the speed of the batch trucks to 20 miles per hour and required batch truck operators to ease gently into the skip to avoid capsizing at full elevation of the bed.

New Machines Used

The first two units were paved in 24-foot widths using two Worthington dual drum mixers using street headers and a 24-foot finishing machines. On the final four-mile unit the contractor used, for the first time on the West Coast, a three-drum mixer. It obtained a production rate up to



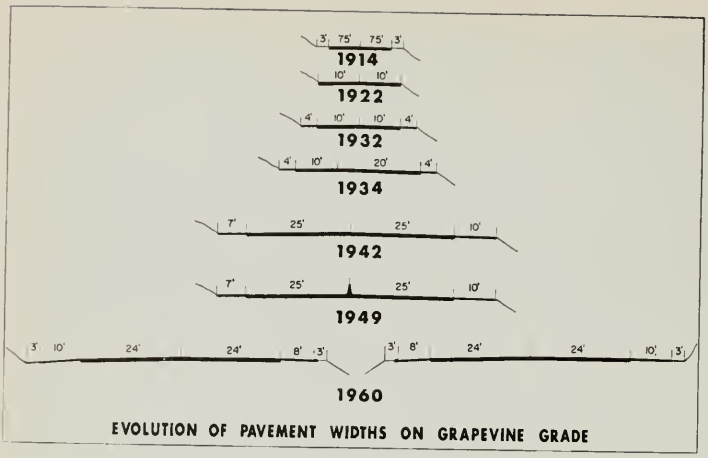
Looking north from the south end of the project toward Fort Tejon Overcrossing with Old Fort Tejon in left middleground of the picture.



Looking south into the canyon from the north end of the project. The new Wheeler Ridge truck scales and inspection area can be seen at the right. Grapevine Interchange is at the foot of the grade in the background.



The Fort Tejon Overcrossing under construction. The view is southward.



EVOLUTION OF PAVEMENT WIDTHS ON GRAPEVINE GRADE

200 cubic yards per hour as compared to 135 cubic yards for the dual drum type.

During the final stage of construction, as an experiment to provide a roughened surface for the truck lanes on this four-mile uphill section of pavement, small chips (⅜" minus) were spread on the fresh surface just ahead of the burlap drag. The chips were hand broadcast from the float. The burlap drag pulled the chips over the surface with a scoring effect.

Excavation Needs Reduced

In addition to providing for the roadways, it was also necessary to carry Grapevine Creek in this narrow canyon. If it had been left to follow an open channel the excavation costs for the roadway would have been enormous. About 9,000 linear feet of closed conduit and 2,000 feet of concrete flume were constructed to minimize the amount of roadway excavation required. The conduit consisted of a 10-foot by 8-foot reinforced concrete box culvert, and is capable of carrying 3,000 cubic feet per second with an allowance for a debris load of six cubic yards per second.

The contractor began work on May 13, 1958, and the contract was accepted on July 22, 1960. The project is 6.6 miles in length and the total construction cost was $7,430,000. It is the first completed project in District VI on the Interstate Highway System.

Acquisition of rights-of-way for this project was no less complicated than the construction. Approximately 350 acres of new area, plus the underlying fee in the existing road was required. Because of widths of traveled ways, terrain and slopes, right-of-way widths throughout the project ranged from a minimum of 330 feet to a maximum of 860 feet. In addition to the right-of-way for the highway, certain replacement easements for the relocation of public utilities outside of the right-of-way area were required.

Appraisal a Challenge

The acquisition affected a total of only 10 owners, but the variety of land uses for areas within the proposed right-of-way and the surrounding lands made the appraisal work challenging and more than routine.

An aerial photo of the overall project possibly indicates mountainous and convoluted terrain suitable only for grazing cattle. A closer inspection on the ground, however, reveals many different types of land use within the area of the proposed right-of-way. Included among these types are the following:

Rocky hillside; marginal grazing land; level lush grazing meadows; fairly level foothill grain land; irrigable agricultural land; small residential sites; a picnic ground area studded with large oak trees and leased by a large oil company, with parking and picnic facilities to handle crowds of 3,000 people; three commercial sites containing many types of improvements catering to the needs of the highway travelers; three oil line pumping plants, and one use not very noticeable to the casual observer—the location of many underground pipelines transporting oil and gas from the oil fields of San Joaquin Valley to the Los Angeles area. Also included is a private water line transporting this vital, scarce commodity from the top at Lebec to various locations along the canyon. In addition, crisscrossing the old highway through the length of the canyon were overhead telephone lines and transmission power lines sagging between high steel towers.

Utility Costs

The cost of utility relocations, for which final payments are still being processed, is approximately $1,300,000. Involved in the relocation were the following:

Two eight-inch oil lines, 8,300 feet long; one 26-inch gas line, 7,500 feet long; one 26-inch gas line, 7,000 feet long; one 10-inch oil line, 8,500 feet long; one 16-inch oil line, 11,000 feet long; approximately four miles of overhead power lines and also aerial telephone lines of short distances.

In order to keep the pipelines on the same relative elevation they previously had so that additional pumping facilities and maintenance costs would not be necessary, a utility bench was constructed adjacent to the roadway. This bench of approximately 27.5 feet in width was backfilled with 5 feet of select material to facilitate trenching operations by the pipeline companies. The surface of this utility bench further serves as off-highway access for the utility companies and also as a cattle trail road for the some 15,000 to 20,000 cattle of the Tejon Ranch Company which travel back and forth between the higher and lower elevations for winter and summer grazing.

Land Types Vary

The largest property owner, the Tejon Ranch Company, owns some 277,000 acres on both sides of the

existing highway through Grapevine Canyon. Approximately 98 percent of the right-of-way involved this owner. Every type of land use involved in the acquisition was included in this ownership. It was necessary to evaluate all the types of land involved as well as to determine the effect of the full freeway on the cattle operation. Three cattlepasses were established beneath the traffic lanes which connected to the aforementioned cattle trails, enabling the ranch to utilize its land on both sides of the highway.

Due to the short interval between planning this project and the construction advertising date there was insufficient time to appraise and negotiate for the right-of-way prior to the scheduled commencement of construction. Consequently, it was necessary to secure a right of entry from the Tejon Ranch Company before the appraisal of the property was even begun.

Negotiations Carried Out

Negotiations were carried out on the basis of this right of entry for approximately two years. Because of various lessees' interests which required legal determination condemnation action was instituted. It is anticipated that negotiations will be concluded shortly for the entire project.

The right-of-way requires the acquisition and/or bypassing of commercial improvements which have served the traveling public along the old highway. Now that construction of the new freeway is complete, it is probable that more and better facilities will be constructed on the frontage roads at the two interchanges, one opposite Fort Tejon and one close to the foot of Grapevine Grade. Installation of these new, modern functional commercial improvements are already planned by the owners of the adjoining property. In addition to the eight-lane divided full freeway enabling the traveling public to traverse between San Joaquin Valley and the Los Angeles area faster, safer, and more comfortably, the services offered for their welfare and needs will be provided at more suitable locations and reached with greater ease and safety and fewer traffic conflicts.



The view southword from the top of the grade with the Fort Tejon Interchange at the center of the picture.

Division Engineer Receives 700-Dollar Award

The State Merit Award Board has authorized an additional award of $700 to James T. McWilliam, Assistant Highway Engineer with the Division of Highways Planning Survey in Sacramento. McWilliam played the major role in designing a drafting projector which is now in use in all highways drafting offices and which resulted in substantial savings to the division.

The new projector makes it possible to change map scales in a shorter time and with a greater degree of accuracy than equipment used previously.

Reorganization

Third Deputy Position Created; Engineers Promoted, Reassigned

A REGROUPING of headquarters engineering and administrative functions in the California Division of Highways, including the appointment of a third Deputy State Highway Engineer, has been announced by State Highway Engineer J. C. Womack.



J. W. TRASK

The new organizational pattern, the first major revision in the Division of Highways staff structure since the second deputy position was established in 1955, is designed to improve the division's efficiency in handling a highway program which has increased in size and complexity since federal legislation accelerated highway planning and construction nationwide four years ago.

California's expenditures for state highway purposes are now about double the size of the 1955 program.

The following promotions and assignments became effective September 1, 1960:

J. W. Trask, promoted from Assistant State Highway Engineer—Operations to the position of Deputy State Highway Engineer—Planning.

J. P. Murphy, Deputy State Highway Engineer—Engineering, assigned as Deputy State Highway Engineer—Operations.

C. E. Waite, Deputy State Highway Engineer—Administration and Management, position retitled Deputy State Highway Engineer—Administration.

George Langsner, promoted from Engineer of Design to Assistant State Highway Engineer—Administration.

Lyman R. Gillis, Assistant State Highway Engineer—Administration, transferred to Assistant State Highway Engineer—Operations.

Willard L. Warren, Assistant Engineer of Design, promoted to Engineer of Design.

Each of the three Deputy State Highway Engineers will be responsible for specific groups of functions, providing for clear administrative lines of reporting and action.

Waite, as Deputy for Administration, will oversee the work of the administrative departments under Langsner, including the functions of the Office Engineer, Federal Secondary Roads, City and Co-operative Projects, Service and Supply and Management Analysis; the Accounting Dement; and Personnel and Public Information.



GEORGE LANGSNER

Murphy, as Deputy for Operations, will be concerned with the functions of Construction, Maintenance, Equipment, and Materials and Research, grouped under Gillis' direction; and



WILLARD L. WARREN

the Bridge Department, headed by Assistant State Highway Engineer J. W. McMahon.

Includes Advance Planning

Trask's areas of responsibility as Deputy for Planning will include the Advance Planning, Traffic, Planning Survey, Programs and Budgets, and Design departments which report to Assistant State Highway Engineer J. A. Legarra; and the Right-of-way Department.

Trask, the new Deputy for Planning, has been with the Division of Highways since 1928, starting as a junior bridge engineer. He worked on bridge and tunnel construction for most of his early career, and then on administrative assignments. He moved to District II (Redding) in 1943 as office engineer and became District Engineer in 1950. In 1956 he was transferred in the same capacity to District III (Marysville), and was pro-

moted to Assistant State Highway Engineer—Operations in February 1957.

Trask was born in Lincoln, Kansas, was raised in Denver, and is a graduate of Utah State University. He served in the U.S. Army Engineers in World War I.

Langsner, who steps up to Assistant State Highway Engineer—Administration, joined the Division of Highways in 1931 upon graduation from the California Institute of Technology. He served in the Los Angeles district (District VII) in positions of increasing responsibility, including design and other work in planning the Los Angeles metropolitan area freeway system, and became District Engineer there in 1955. He was transferred to Sacramento headquarters office in 1957 as Engineer of Design. He is currently chairman of the Committee on Design of the American Association of State Highway Officials.

He is a native of Brooklyn, New York.

Ten Years With Department

Warren, as the new Engineer of Design, will head the department with which he has been associated for the past 10 years, most recently as chief assistant to Langsner.

He was born in Kentucky. After studying engineering at the University of California, he served with the Nevada Highway Department from 1936 to 1942, then worked for the Army Corps of Engineers during World War II. In 1946 he joined the California Division of Highways in the Marysville District (District III) and was resident engineer on construction projects in Sacramento and Yolo Counties.

Warren's recent work has included the development of pavement design and studies of pavement performance. He developed the system of economics for pavement design and operation now in use by the Division of Highways.

Two new cities have become incorporated. They are Temple City, Los Angeles County, population 37,758, and Sand City, Monterey County, population 360.

PROGRESS REPORT FOR CALIFORNIA'S CONGRESSMEN



To keep California's 30 Congressmen and two United States Senators better informed on the progress of Interstate and other freeway planning and construction in the State, the Division of Highways recently prepared a special large size map in which the status of the various routes and projects is shown in color. Explaining the principal features of the map to Representative Jeffery Cohelan (right) of Alameda County is State Highway Engineer J. C. Womack with State Director of Public Works Robert B. Bradford at far left. Congressman Cohelan is secretary of the California Congressional delegation.

HIGHWAY EMPLOYEES 25-YEAR AWARDS ANNOUNCED

Headquarters Office
Ernest A. Winkelman

District IV
Julius Hyland

District V
Clarence L. Hummel

District VI
Ray A. Middleton, Joseph J. Seale

District VII
John E. Gere

District X
William V. Abersold, Frank E. Randolph, Mamo Snooks

District XI
Henry Box

Materials and Research Department
Roy F. Carter

Shop 7
Fred A. Bushling

Shop 8
Floyd J. Weeks

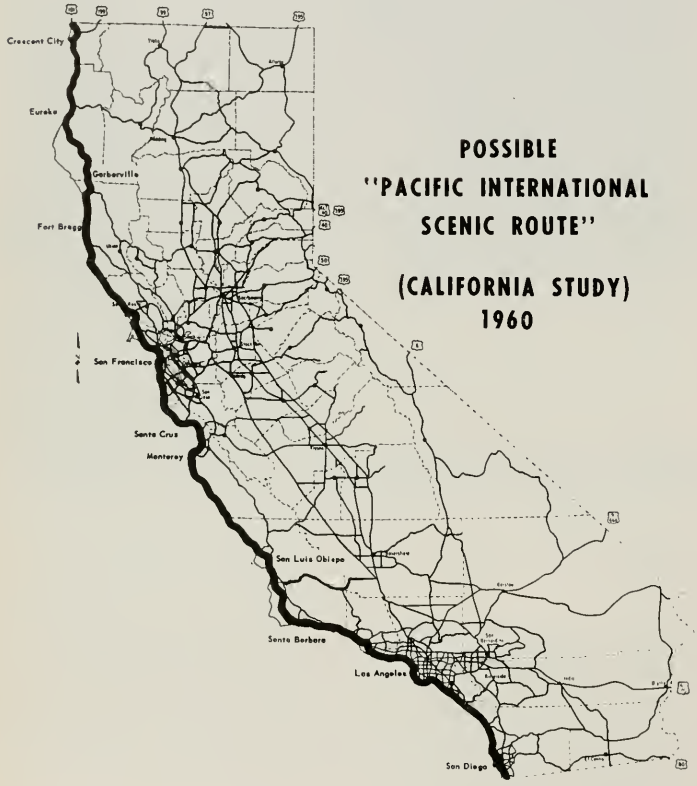
A record high for one day of 56,973 vehicles crossed Carquinez Bridge on Saturday, July 2. The previous high record was 54,557 vehicles on May 30. The San Francisco-Oakland Bay Bridge also reported a new record. An average of 110,411 vehicles a day crossed the bridge during the month of June, the highest daily average for any month since it was built.

The State Department of Public Works has awarded a $16,237,675 contract to Guy F. Atkinson Company, Long Beach, for construction of 7.4 miles of eight-lane freeway (San Diego Freeway) between 0.3 mile south of Casiano Road and 0.3 mile north of Valley Vista Boulevard, south of the Ventura Freeway, in Los Angeles.

CALIFORNIA'S SCENIC DRIVE STUDY IS COMMENDED BY WESTERN GROUP

California's preliminary studies and proposed future study looking toward a "Pacific International Scenic Drive" from the Mexican to the Canadian border are serving as an example for similar studies by other Pacific Coast states.

The proposal is also being expanded to extend into British Columbia and Alaska.



As reported in the May-June issue of *California Highways and Public Works*, the proposal was submitted to Governor Edmund G. Brown on April 20, 1960, by his Standing Committee on Public Works and Natural Resources. It envisions a 1,030-mile route in California following, in general, the coastal area of the state.

The California study and outline for an extension of the coastal scenic drive through Oregon and Washington was presented to representatives of those states, plus others from British Columbia and Alaska, at a meeting in Seattle on July 20. The meeting was called by Governor Albert Rosellini of Washington. Governor Brown was represented by State Senator Randolph Collier of Yreka, chairman of the Senate Committee on Transportation, assisted by Deputy Director of Public Works Harry D. Freeman.

The representatives of the three other states and British Columbia commended the California report and agreed to consider it as a guide for their own studies of a scenic route.

Further discussion on the proposal will take place at a meeting scheduled for some time in October in Victoria, B. C.

Freeway Design Is Subject of Report

A review of freeway design and its effect on traffic is the subject of a 22-page report by George A. Hill, formerly Assistant Engineer of Design for the Division of Highways and now District Engineer—Planning of District VII in Los Angeles.

Entitled "Designing Better Freeways," the report is based on a talk given by Hill before the Institute of Traffic Engineers Seminar at Santa Barbara in June 1959 and at Denver in November. Through the use of some 30 photographs and diagrams the report presents major problems involved in the designing of freeways and freeway interchanges and how they are being alleviated through research and advanced design practices.

Some of the features of freeway design considered by the report are: on and off ramps, weaving traffic, shoulders and median strips as refuges for stalled vehicles, advance signing, proper location and spacing of interchanges, speed change lanes and channelization. Specific examples are cited and illustrated from the California Freeway and Expressway System.

Some important factors in freeway design are summarized at the end of the report.

SAN LUIS ROUTE ADOPTED

A freeway route for the relocation of 14 miles of State Sign Route 152 (Pacheco Pass Highway) around the proposed San Luis Reservoir in Merced County was adopted at the August meeting of the California Highway Commission. A total of 28.5 miles of freeway routes was adopted at the meeting, bringing the total mileage of such routes to 5,294.

Utility Moving

Huge Clearing, Relocation Problem on San Diego Project

By J. R. CROPPER and D. S. SHEPARD, Resident Engineers



PROBABLY one of the least publicized problems of freeway construction is the relocation of utility facilities. This is especially true when a freeway is to be constructed through a metropolitan area. Unnoticed to the average motorist are the miles of underground water, sewer, gas and telephone lines. There is even only minor recognition given to the overhead power and telephone lines.

In the majority of instances these utility lines are not of record-breaking size or carry any special significance, other than to perform the utilitarian duty of providing service to the homes, offices and improvements in the immediate vicinity. The freeway design can be as effective in severing this utility system as if it had been cut with a knife.

District XI has just completed plans for the construction of a portion of the San Diego Freeway (US 101) through the center of the more heavily populated section of San Diego. The improvement in general consists of the construction of an eight-lane freeway with appropriate interchanges and separations. For construction convenience the project was divided into several units. Unit one encompasses mainly the construction of the US 101-US 395 interchange. Figure (1) shows a model of this interchange which was constructed by the Division of Highways Bridge Department.

Unit two joins unit one at Sixth Avenue and extends one mile and a quarter northerly to Palm Avenue. A low bid of $5,219,340 for construction of this unit was submitted on August 25 by the R. E. Hazard Company of San Diego in joint venture with the W. F. Maxwell Company of Fontana.



Cleared areas for freeway construction in San Diego can be seen in the above photo beginning lower right and ending upper middle.



Cleared areas start at right center and curve toward upper left portion of the above photo.



Water line relocation at Ninth and Ash Streets in San Diego.



Underground telephone conduit installation on H Street.



Underground telephone lines were temporarily detoured by leading them out of the ground and suspending them between poles as in the above photo taken at Sixth Avenue.



A view of the Cabrillo Freeway before clearing operations began.

Breakdown of Costs

The total cost of utility relocations for these two projects is $802,500, of which the utility companies are paying $244,400 and the State is paying $558,100. This breakdown of cost is made by giving recognition to betterment of facilities and in accordance with the statutes relating to the Division of Highways, Department of Public Works. Included in this utility relocation work are 2.5 miles of water lines, 1.75 miles of sewer lines, 1.15 miles of gas mains, 2.0 miles of electric power lines, 3.6 miles of telephone cables and 1.7 miles of fire alarm cables.

As much work as possible or practical is performed before the contract work is started. This includes the relocation of utility lines and abandonment of existing utilities within the immediate work limits of the contract. In numerous cases the utility line cannot be relocated to its final position until some portion of the contract work is finished. In these cases a temporary detour of a utility line will have to be constructed and used until such time as it can be located in its ultimate position.

It has been proven from past experience that construction and relocation of the sewer and water lines which cannot be completed in advance of highway construction can be handled with more overall efficiency if the work is made a part of the highway contract. This eliminates to some

extent the delays which would occur due to waiting for an opening in the work schedule of another agency. Of course, improvements belonging to private agencies, such as telephone, electric power and gas lines have to be handled by their forces.

Cables Are Removed

A typical example of the problems to be encountered are the existing telephone lines in the vicinity of Fourth, Fifth and Sixth Avenues. The existing cables carry the main trunk and television lines supplying San Diego, and are buried in the streets. To avoid conflict with the new structures, the existing cables have been taken out of the ground and placed on temporary poles over the structure area (Figure 2). After the structures have been completed, the cables will be installed through the inside of the structure girders and the temporary pole lines removed. It is anticipated that approximately 10,000 manhours of splicing will be required to relocate the telephone facilities in Fourth, Fifth and Sixth Avenues alone.

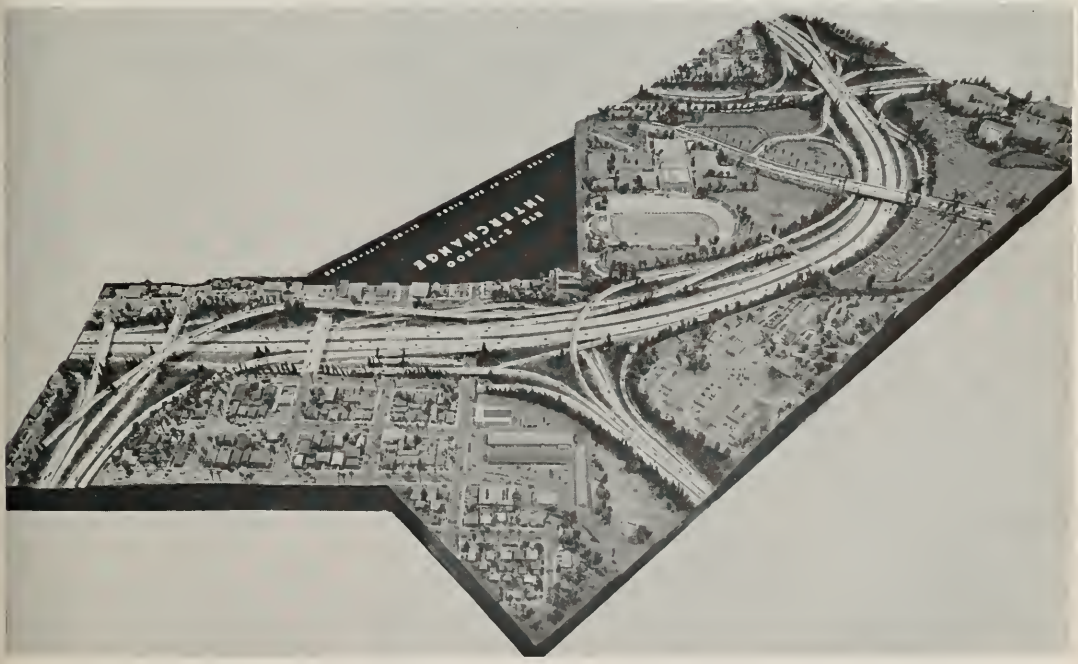
Other examples of how some of the utility relocations affect the contractor's operation are the water and gas lines in Unit No. 1.

An existing 12-inch high-pressure gas line crosses the freeway where a deep cut is planned. To avoid the deep trenching that would be necessary to lower this line before freeway construction, the highway contractor will be required to stay clear of the gas line until he is down to grade at the new location of the gas line approximately 250 feet to the east. At that time the relocated utility can be placed with relatively little trenching. Also a 24-inch water line passes through the heart of the project. To avoid having additional contractoral delay this line was placed in a temporary location adjacent to the above mentioned gas line. It then will be handled similarly to the gas line and at the same time.

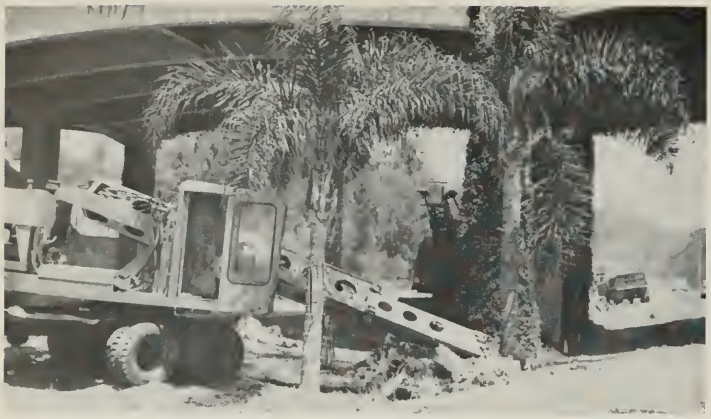
Contract Is Awarded

Following closely on the heels of utility relocation is the advertisement and award of the highway construction contract. Unit No. 1 was awarded to the Daley Corporation and R. M. Price Construction Co. on June 10, 1960. Bids are currently being asked for Unit No. 2 and the contract award should be made early in September.

The contractor's first order of work is usually clearing and grubbing. The clearing of a freeway in the San Diego metropolitan area usually consists of some heavy dozer work with an occasional assist from a crane and headache ball to clear the jumble of building remains, walls and pavements that occur on a downtown freeway right-of-way. Unit No. 1 presented a somewhat different situation. A major portion of this unit fell within San Diego's famed Balboa Park. This area contained trees of several types ranging in size up to 125 feet tall with a butt diameter of 60 inches. Among the types found were cypress, spruce, fir,



This model of the US 101-395-Sign Route 94 interchange in San Diego shows how the structure will appear following its completion.



The start of excavating operations to salvage a palm tree from the median strip of the Cabrillo Freeway.



A crane lifts the salvaged palm and swings it toward the truck.



The palm is lowered into the truck for hauling to a tree storage lot.

pine, redwood, eucalyptus, acacia and sycamore. The proximity of the growth in the rest of the park prevented felling and burning of the trees in place. This gave the contractors, Daley Corporation and R. M. Price Construction Co., a chance to practice logging.

The trees were dropped using chain saws and dragged to the nearest available road by a tractor. Here rubber-tired equipment took over and hauled the debris to a disposal area at the southeast end of the project. At this point the local lumber yards took over. To further complicate the situation, many of the trees were in a 54-foot median on the existing Cabrillo Freeway (US 395). As the contract specifically prevents the contractor from interrupting the flow of traffic on this high speed freeway, the removal method had to be changed. The trees were trimmed before felling as a safety precaution and the trunks loaded on trucks. The branches were fed to a machine known as the chipper, which almost instantaneously would reduce a large branch to a small pile of chips. Most of these trees in the median were sycamore up to 30 feet high that were planted as part of the landscaping of the Cabrillo Freeway in 1948.

Easy to Transplant

Among the trees within the right-of-way were 25 palms of various types. As this type of tree is relatively easy to transplant and fits nicely into freeway landscaping, the palms were moved into a nearby lot for future use. The transplanting was by extra work costing $3,500 which added to the contract price for clearing and grubbing, gave a total clearing cost of $65,000 for Unit No. 1. All of these clearing costs added to the utility relocation work show that it will cost almost $900,000 to prepare the site for actual highway construction. This cost is of course exclusive of the costs for the real property purchased.

Unit No. 1 is scheduled for completion in February of 1962 and Unit No. 2 for August of the same year.

County Plan

Co-ordinated Program Puts Road Funds Where Need Is Greatest

By A. S. KOCH, Surveyor and Road Commissioner, Orange County

It is generally recognized that the existing formulas for the distribution of highway financing creates many inequitable situations throughout the various levels of government. Whether it is recognized as a fact or not, it would be virtually impossible to formulate an equitable distribution of gas tax funds statewide, since the situation in each of our counties is essentially unique.

There is a tendency on the part of local governments to complain that the proportional split of the gasoline tax between the cities and the counties is inequitable. Equity can be based only on need, however, and any other basis of complaint is just as arbitrary as the original division of gas tax funds itself. The gasoline tax is intended to serve the motoring public as a whole. Consequently, where local inequities occur, and they will always occur, they should be recognized and a redistribution of funds worked out locally to suit the local situation.

County Should Equalize

Orange County's contention is that county government is the agency which should equalize such a redistribution program. County government is in a position to co-ordinate a program between the county and the cities involved. County government represents all the people and should be equally interested in the citizens of the incorporated areas, as well as those outside such areas. County government, therefore, is in a position to see that the funds available are spent to the best advantage of the county as a whole.

Maximum benefit is obtained from the highway tax dollar by improving the most important streets and roads where the need is greatest. A program based on these principles can, and should be worked out locally, and in the end is probably the best method of solving the equity problem. It could finally eliminate the allocation fight that has prevailed for many years.

Such a program implies the necessity for an overall plan which expresses the communities' ultimate needs. Such a plan of course is a master plan of the circulation element of the community's general plans.

The author of this article, in addition to being very active in the County Engineers Association, has participated in highway matters at the state level for some time. He was a member of the Advisory Committee to the Department of Public Works in connection with the county road and city street deficiency study (SCR 62) reported elsewhere in this issue; and in 1957-58 he was on the Technical Advisory Committee for the California Freeway System study (SCR 26).

The article was reviewed and concurred in unanimously by the entire board of supervisors of Orange County: C. M. Featherly (Chairman), William H. Hirstein, Claire M. Nelson, William J. Phillips and Willis H. Warner.

In Orange County, we began working on this phase of the problem in 1954. The tremendous expansion that has taken place in Orange County and which continues at a tremendous pace had just started to become evident. The necessity for the development of a master plan of arterial highways became obvious.

Responsibility Accepted

At the request of the board of supervisors, the Associated Chambers of of Commerce, an organization representing all chambers of commerce throughout the county, accepted the responsibility of sponsorship for the development of the master plan. This organization's committee, working closely with the county planning commission and the county road department, sponsored the many meetings which were necessary with all governmental agencies and community organizations which were interested in the problem.

After 18 months of very hard work on the part of the county departments and the sponsoring association, a plan was developed in which was incorporated the overall reasoning of all of our community. It had the basic agreement of all the cities throughout the county. The plan gave us a good basic groundwork on which to build until we were able to approach the final phases of our co-operative program. That program is one of 100 percent co-ordination between all governments on a countywide basis for the development of highways and streets.

The second phase of development of the plan consisted of the establishment of those tools of government which would make it possible to eventually develop the overall road system. These tools consist of such accomplishments as setback ordinances, geometric standards, and establishment of access control, under the constant surveillance of the board of supervisors and the planning commission.

A setback ordinance which has been in existence in Orange County for many years was updated to provide for the practical standards which had been established for the arterial highway system. Such a setback ordinance provides basically for the preservation of ultimate rights-of-way in order that roads can be expanded as needed.

Access Is Minimized

Access control to the arterial highways is gained primarily by requiring subdivisions and commercial developments to recognize the principles of modern design in order that vehicular access to our main thoroughfares can be minimized. The Orange County



MASTER PLAN of ARTERIAL HIGHWAYS COUNTY of ORANGE, CALIFORNIA

subdivision ordinance provides that in the development of a new subdivision the subdivider must dedicate the vehicular access rights to the public except at intersecting streets in order to preserve the integrity of the arterial highway system. Fortunately, this concerted action on the part of the community as a whole has created much interest on the part of the cities in the development of similar conditions for the development of a good highway system.

These efforts on the part of all levels of government in the county then brought us to the third phase of our overall county co-operative program. This phase was of course the development of a financing program which would make it possible for the county as a whole to realize the ultimate development of this system of highways and to eliminate the chaos which generally has prevailed in the past in the development of such an ultimate program. This co-operative highway financing program was agreed upon by the board of supervisors and the Orange County League of Cities in October, 1958. It has since been referred to as the arterial highway financing program.

The program is designed to satisfy the greatest traffic needs on the county arterial highway system. It is this theme which we ask the reader to follow as we discuss the details of the program now in operation.

Basic Concept

The basic concept of the program is for the county to furnish financial assistance to the cities in order that the arterial highway system may be developed equitably throughout the county. First, in order to participate, the agreement provides for three very definite actions on the part of all participants. At present 18 of the 22 cities and the county have qualified by the accomplishment of these three factors. They are:

1. A mutually satisfactory master plan of arterial highways must be approved.
2. Mutually satisfactory uniform structure setback lines to protect the ultimate rights-of-way must be adopted by ordinance.



Harbor Boulevard (between the Cities of Santa Ana and Costa Mesa) was built cooperatively as a Federal Aid Secondary highway using the Arterial Highway Financing Plan.



The Nicolas Avenue Underpass (in the City of Fullerton) was built cooperatively by two railroads, the State and the Arterial Highway Financing Plan.



The Nicolas Avenue extension (between the Cities of Fullerton and LaHabra) is being built on a new alignment, financed through the Arterial Highway Financing Plan.

3. Mutually agreeable provisions for the limitation of access to the arterial highway system must be established in order to protect the integrity of the system.

These three points are fundamental and are the three basic factors which will make it possible to ultimately construct a satisfactory arterial highway system throughout the county.

We have agreed, of course, on other factors. Among them, the county has agreed that the program shall apply only to the arterial highway system as master planned. The county has agreed that its highway users taxes which are collected from the highway users as a whole will be spent only on that county arterial highway system. Of course, cities are already limited in spending gasoline taxes on their major street system as far as construction is concerned. It remained then only for them to agree that the major street system in each city will coincide with the approved arterial highway master plan wherever practical.

Obviously, certain exceptions are necessary. The smaller cities which are relatively unconcerned with the arterial highway system can qualify major city streets for financial assistance whether or not these are part of the master plan.

In addition to the foregoing factors, it has been agreed that standards for all routes on the master plan of arterial highways will be established. This can be a long-drawn-out process and for that reason we are at present limiting the standards to the consideration of traffic-carrying capacity only.

Funds Are Matched

The program as set up is a mutual program in all respects. It is a matching program in that highway users tax funds apportioned to the county and expended in the cities under the program must be matched by the city involved if it is financially possible to do so. Thus, the city's yearly program of arterial highway development can be effectively doubled by the arterial highway financing program. However, the program recognizes the possibility that a smaller city may have an extremely high priority project from a countywide standpoint and yet be unable to finance it. In this event, assuming that there is an unobligated balance in the program funds, it has been agreed that the county may finance part or all of a project. This has already been done on certain links in the arterial highway system which were considered of as much importance to all surrounding cities as to the city in which the project was constructed.

An advisory committee, composed of three elected officials appointed by the Orange County League of Cities and two elected officials appointed by the board of supervisors, has been formed to advise the board of supervisors on the establishment of the fiscal program and to co-ordinate the general advancement of the arterial highway financing program. A technical staff, composed of the county road commissioner and five city engineers, works under the advisory committee. The primary duties of the technical staff are to administer the arterial highway financing program, to collect and evaluate technical data, and to make such recommendations as required by the advisory committee.

It is the board of supervisors which ultimately determines the projects that will receive allocated funds. With the assistance of the advisory committee, it determines which projects among those applied for by the cities each fiscal year are of the most importance to the county as a whole and funds are provided for the construction of these. Projects not of the greatest importance are deferred, to be considered at a later date.

Limitation on Funds

As the county does not have unlimited funds with which to participate in such a program, it is necessary that some limitation be placed on the funds available for each year. The board of supervisors annually allocates to this program a portion of its highway users taxes. The amount is determined by the ratio of the mileage on the arterial highway system in the incorporated areas to the total arterial highway mileage in the county after first deducting the amounts required for administration and maintenance of its own arterial highway mileage. Thus the cities and the counties share the funds available for construction, on the basis of their arterial highway mileage alone.

It should also be of interest that it has been agreed that funds allocated in any fiscal year that are not committed to an advertised project by the end of the fiscal year revert to the county highway program. The idea behind this procedure was to insure that the highway funds available to the counties and the cities be put into roads and not kept in the bank.

We are now in the third fiscal year of the program. In both preceding fiscal years, all funds have been committed by the cities and no funds have reverted to the county. We believe that this fact alone speaks well for the enthusiastic reception of the program throughout the local jurisdictions of the county.

In these three fiscal years, we have allocated funds to 72 individual projects in incorporated areas. The total moneys involved including the city and county contributions on these projects will be well over $5 million. Of the 72 projects, 40 were for widening two-lane streets to a modern four-lane standard; 12 were for projecting new roads through areas of new development where arterial highways are required and are a part of the master plan.

We have consistently rejected projects of a maintenance nature regardless of the standard definition of maintenance. Any application for a project that resembles maintenance rather than a definite development of traffic carrying capacity of the arterial highway system has been turned down.

Many advantages have accrued from our master plan other than just the development of adequate streets and highways. Our plan has readily gained state recognition. The State Division of Highways has recognized the plan in the planning of freeways and in the development of freeway agreements. Many of the streets which are not now in existence have been recognized in the planning of freeways and at the time of construction we are able to develop in advance the interchanges or separations which will

. . . Continued on page 56

SCR 62 Report

Road Needs of Cities, Counties Inventoried at $12 Billion Plus

THERE are 100,000 miles of county roads and city streets in California which will need improvement over the next 20 years at a total cost of about $12,750,000,000.

These estimates were contained in a report submitted to two legislative committees in the State Capitol on September 6 by the Department of Public Works after a year-long study conducted by the Division of Highways in co-operation with all 58 counties and 361 cities.

The study was authorized by Senate Concurrent Resolution No. 62 of the 1959 Session, introduced by Senator Richard Richards of Los Angeles, as a basis for analysis of the need for accelerated financing of city street and county road improvement.

The report does not specifically recommend a gasoline tax increase or other financing measures. It pointed out that the legislative committees and the public should first have a chance to study the engineering data.

As submitted to the Senate Fact-finding Committee on Transportation and Public Utilities, of which Senator Randolph Collier of Yreka is chairman, and the Assembly Interim Committee on Transportation and Commerce, of which Assemblyman Lee M. Backstrand of Riverside is chairman, the report contains a county-by-county and city-by-city estimate of road and street needs for four successive five-year periods beginning in 1960 and ending in 1980.

Nearly $2 billion worth of improvement is needed right now to make the local roads and streets adequate for present-day traffic, the report shows. Looking ahead to 1980 and its estimated traffic needs, the total cost would amount to $12.75 billion.

> Copies of the SCR 62 report on California County Road and City Street Deficiencies are available to interested persons, although the supply is somewhat limited.
>
> Those who would find a copy of the report useful may request one by addressing Mr. F. M. Reynolds, Planning Survey Engineer, California Division of Highways, P. O. Box 1499, Sacramento 7.

Improvement is or will be needed on 25,220 miles of the 42,765 total city street mileage, present and planned; and on 74,974 miles of the 102,677 total county road mileage, present and planned.

Studies of possible financing approaches are being carried on by Richard M. Zettel, staff director for the Senate committee. Among the alternatives under preliminary consideration are a one-cent per gallon increase in the gasoline tax or a $1 per $100 valuation increase in the "in lieu" tax on motor vehicles, paid at registration time.

Both State Director of Public Works Robert B. Bradford and State Highway Engineer J. C. Womack, in forwarding the report emphasized the high degree of state-city-county co-operation that produced it, and the value of the technical advisory committee which helped to chart the course of the study.

Womack said that the study "developed what we believe to be the most complete, practical and representative estimate of present and future city street and county road needs that has ever been prepared for legislative review."

This view was also taken by the advisory committee. In a statement submitted by its chairman, Supervisor Francis E. Dunn of Alameda County, the committee termed the report "the most realistic report of critical deficiencies on city streets and county roads which has ever been prepared."

The report contains numerous tabulations of street and road deficiencies as prepared by the local agencies and audited by the Division of Highways on a uniform basis.

The county roads are analyzed according to the required expenditures for rights-of-way and for construction

SUMMARY OF NEEDS

	System miles	Deficient miles	Estimated right of way and construction costs ($1,000) 1960	1965	1970	1975	1980	Total
CITIES								
Major arterials	5,570.5	3,164.9	470,625	511,165	403,466	243,111	146,760	1,775,107
Collector streets	4,807.8	3,051.5	213,648	232,290	196,696	133,145	122,599	898,378
Local streets-existing	22,612.2	9,482.4	216,314	239,055	231,473	172,413	166,119	1,025,374
Local streets-future	9,774.8	9,521.6		482,118	417,785	263,855	267,423	1,431,181
Total Cities	42,765.3	25,220.4	900,587	1,464,628	1,249,400	812,524	702,901	5,130,040
COUNTIES								
Primary roads	17,487.5	15,196.1	467,594	381,614	442,537	289,644	227,229	1,808,618
Secondary collector roads	14,413.2	12,697.8	260,531	195,478	252,705	157,401	143,734	1,009,849
Other secondary roads—existing	40,513.1	17,527.9	355,943	102,976	119,038	87,976	87,566	753,499
Other secondary roads—future	30,262.8	29,551.9		687,101	731,854	781,482	1,849,540	4,049,977
Total Counties	102,676.6	74,973.7	1,084,068	1,367,169	1,546,134	1,316,503	2,308,069	7,621,943
TOTAL CITIES AND COUNTIES	145,441.9	100,194.1	1,984,655	2,831,797	2,795,534	2,129,027	3,010,970	12,751,983

in each county, for each of the four five-year periods, in each of four categories: primary roads, secondary collector roads, other secondary roads (existing), and other secondary roads (future).

City street deficiencies are similarly summarized for each separate city, except that the four categories are somewhat different: major arterials, collector streets, local streets (existing) and local streets (future).

Among the findings and results cited in the report are a pattern for continued future interagency co-operation in similar efforts, a definite boost for local planning, and "the development of an integrated system of highways, roads and streets on a statewide basis."

The report includes a recommendation that the city and county street and road deficiency reports be brought up to date every four years, to coincide with a periodic review of state highway needs.

The study was carried out by the Highway Planning Survey Department of the Division of Highways, under the direction of F. M. Reynolds, Planning Survey Engineer, with members of the planning staff in each of the State's 11 highway districts working closely with the cities and counties in their areas.

Members of the advisory committee appointed by the Legislature, in addition to Chairman Dunn, were:

E. A. Fairbairn, Vice Chairman and Secretary
City Engineer
City of Sacramento

Harry V. Cheshire, Jr.
General Counsel
Automobile Club of Southern California

Ira J. Chrisman
Mayor
City of Visalia

Kenneth Kendricks
Vice President and Regional Manager
Standard Oil Company

A. S. Koch
County Road Commissioner
Orange County

William McIntosh
County Road Commissioner
Lassen County

Edwin S. Moore
Executive Vice President
California State Automobile Association

Claude Minard
General Counsel
California Railroad Association

John A. Morin
City Engineer
City of Oakland

Lyall A. Pardee
City Engineer
City of Los Angeles

Victor W. Sauer
Director of Public Works
Contra Costa County

Wade Sherrard
Managing Director
California Trucking Associations, Inc.

C. Clarke Williams, Director
Highway and Transportation Department
State Chamber of Commerce

RECENT RETIREMENTS FROM DEPARTMENT ARE LISTED

Public Works—Administration

Bert Sellier, Assistant Comptroller, 33 years

Headquarters Office

Merritt Nickerson, Supervising Photographer, 33 years

District I

Oney Harmon, Highway Foreman, 40 years

William Hickox, Highway Equip. Oper.-Lab., 33 years

Neil E. Kemp, Assistant Highway Engineer, 33 years

John V. Maciel, Highway Equip. Oper.-Lab., 31 years

Charles P. Sweet, Supervising Highway Engineer, 38 years

District II

Victor Lammers, Highway Equip. Oper.-Laborer, 25 years

Francis Noel, Associate Highway Engineer, 26 years

Roy Thorpe, Highway Foreman, 33 years

District III

Dewey Gamlin, Highway Equip. Oper.-Laborer, 34 years

District IV

William E. Chatfield, Assistant Highway Engineer, 6 years

Dorothy R. Frank, Supervising Steno.-Clerk I, 31 years

Charles A. Weber, Highway Leadingman, 25 years

District V

Henry C. Anderson, Laborer, 25 years

William S. Dolliver, Senior Highway Engineer, 35 years

* Ralph Sterling Leeds, Sr., Carpenter I, 12 years

Thomas D. Slankard, Highway Equip. Oper.-Laborer, 26 years

District VI

John Adams, Associate Highway Engineer, 32 years

Harry M. Payne, Highway Foreman, 28 years

Forest W. Pfrimmer, Highway Equip. Oper.-Laborer, 27 years

District VII

Albert D. Griffin, Supervising Highway Engineer, 41 years

Kenneth M. Trenholm, Supervising Right of Way Agent, 15 years

District VIII

Morris Krieger, Assistant Right of Way Agent, 10 years

District X

Fred R. Holm, Associate Highway Engineer, 37 years

District XI

John J. Lieb, Highway Engineering Technician, 2 years

Grace L. Mullins, Accounting Technician II, 29 years

Bridge Department

Warren B. James, Associate Bridge Engineer, 34 years

Headquarters Shop

Paul F. Younggren, Heavy Equipment Mechanic, 17 years

Shop 1

Edgar R. Quintrell, Highway Mechanic Foreman, 36 years

Shop 2

Robert S. Moss, Automobile Painter, 32 years

* Disability.

Several sections of the state highway system were closed for varying periods of time during August as the result of forest fires.

DIRECTIONS FOR THE TRAVELER

By GEORGE M. WEBB, Traffic Engineer and
R. J. ISRAEL, Assistant Traffic Engineer

FOR HUNDREDS of years, signposts have guided the traveler on his way, whether he be a pilgrim traveling on foot or a motorist on an eight-lane freeway.

A traffic sign nearly 300 years old is located in England at an intersection in the Cotswolds. This is believed to be the oldest signpost in Britain. It is carefully preserved by the British highway authorities. Four iron arms point the ways to Worcester, to Oxford, to Warwick, and to Gloucester.

When a traveler wanted to know how far it was to any one of these towns, he consulted the side of the appropriate arm. It is known as the Cross-Hands.

Pioneer Signs on US 50

Travelers along modern US 50 between Placerville and Lake Tahoe can still glimpse some of the stone milepost on which have been engraved the distance easterly from Placerville.

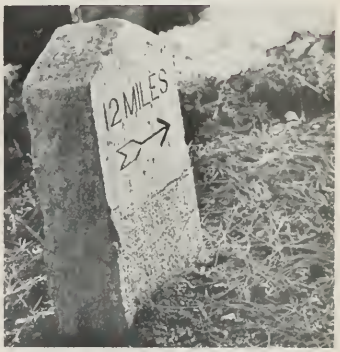
In Central Illinois, rural road markers of a generation ago consist of a map cast in iron, with the location of the particular marker indicated by a star. Thus, by careful and leisurely inspection, the traveler could determine his location and his route.

These signs of bygone days would be of little value with present-day speeds and traffic volumes. Today, traffic signs are recognized as an integral part of a modern highway—essential to its operation and to the safe, orderly, and smooth flow of traffic.

The Division of Highways continually studies and improves signing techniques to keep pace with the ever-increasing traffic demands and to provide California motorists with superior signing service. Signposting has changed throughout the years along with other highway features, but its purpose — to guide the traveler — remains the same as in olden times.



An iron "map" served as a guide to travelers in the early days of motoring in Central Illinois. (Photo courtesy of Macon County Road Department.)



This marker on US 50 in El Dorado County shows the distance to Placerville.

Auto Increased Travel

When the automobile came into popular use, people traveled farther and faster than ever before. Longer trips over new roads were commonplace, and there were more people using strange roads far from their homes. This increased travel, particularly travel for long distances, created a strong demand for legible signs. As highways and automobiles improved, speeds increased, and so did the need for adequate highway signs that could be read from a moving car.

Types of Signs and Uniformity

There are three general types of traffic signs in use today:

1. *Warning* signs to caution drivers of the need for added alertness or reduction in speed;

2. *Regulatory* signs to inform motorists of regulations governing movement;

3. *Guide* signs for guidance and directional information.

Obviously, traffic signs of all types should follow uniform standards and be placed in accordance with uniform practice so they will have the same meaning and result in the same action on the part of motorists wherever en-

countered. Statewide uniformity on county roads, city streets, and state highways minimizes drivers' confusion and contributes materially to the safe, orderly, and expeditious movement of traffic.

National uniformity is likewise important. California follows the general standards of the Manual on Uniform Traffic Control Devices for Streets and Highways approved by the American Association of State Highway Officials, Institute of Traffic Engineers, and the National Committee on Uniform Traffic Laws and Ordinances; and the A. A. S. H. O. Manual for Signing and Pavement Marking of the National System of Interstate and Defense Highways. Statewide uniformity on county roads and city streets, as well as state highways, is encouraged by membership and active participation in the deliberations of the California Sign Committee and other professional groups, including national committees concerned with signing standards.

Rules for Use of Signs

Signs are essential where special regulations apply, where unusual conditions are not self-evident, and to furnish directional information. They should be used wherever there is a real need but not profusely. Too many warning or regulatory signs detract from the effectiveness of those necessary for safety and guidance.

Well-known rules of the road or general provisions of the Vehicle Code are not generally required on traffic signs. Drivers are expected to know the rules for safe operation of their vehicles, and a multiplicity of needless signs with long messages would be distracting and serve no useful purpose.

Guide Signs

Except for the foregoing general comments, this discussion is limited to guide signs. The function of guide signs, as the name implies, is to guide motorists along routes and to destinations of their choice; to inform motorists of intersecting routes; to direct to cities or towns; and, to a lesser extent, to furnish information and to identify locations not readily apparent.

The modern highway with adequate visibility and easy curvature to accommodate all normal driving speeds reduces the need for warning and regulatory signs. However, the increased width and higher speeds, and the necessity for making decisions far in advance of turnoffs or intersections greatly increases the importance of the guide signs. This is particularly true on freeways. Practically no warning signs are needed on freeways except on ramps and connections at interchanges.

Like the early day traveler, the motorist on present-day conventional highways takes advantage of familiar scenes, landmarks, buildings, and geographical features for information as to his whereabouts and the location of intersections and points where choice of direction is made; but on the freeways, with wider rights-of-way and no business or buildings of any kind fronting directly on the highway, identification of location may be more difficult. This further brings out the need for guide signs of adequate legibility placed a considerable distance in advance of turnoffs.



A diamond-shaped yellow sign indicates a warning; reflectorized arrow specifically warns of curve to right ahead.



Speed limit signs are the most familiar examples of regulatory type sign.



Directional information is the purpose of guide signs.



This sign once guided travelers in Southern California but would obviously be impossible to read and digest from a vehicle driving on a modern highway at normal speed.

It has been frequently said that directional signs were needed only for the infrequent user or the complete stranger on a highway. This is not true on the modern highway with access completely controlled and no intersections at grade. Even frequent users need signs to identify locations and turnoffs.

Statewide Problem

The extensive highway improvement program now under way in many cases removes traffic from congested business streets. This traffic is diverted to the newly constructed routes, generally freeways, which bypass the main business district. This makes the subject of adequate directional signing of great interest to many communities and areas throughout the State as well as to the motorist. The statewide scope of the problem requires that it be treated on a uniform statewide basis.

The statewide signing practice of the Division of Highways has evolved through the years in meeting changing conditions, increased traffic, and the growth of communities along the expanding network of modern state highways.

The adoption of a uniform system of signing for interstate highways in 1958 had a major influence on signing practices in this State and throughout the nation. California had a sizable influence in the development of the Interstate Sign Manual and is now participating in the further development and the broadening of these national standards.

California Sign Committee

Current state highway signing practice, while it is the responsibility of the Division of Highways, was not developed by this division alone. Much of it stems from the studies and consultations of the California Sign Committee which was organized to promote orderly, safe, and consistent signing throughout the State. Members of the Sign Committee are the State Division of Highways; California State Automobile Association; Automobile Club of Southern California; County Supervisors Association of California; League of California Cities; Institute of Transportation and Traffic Engineering of the University of California; and the California Highway Patrol. The individuals who represent these organizations on the committee are directly concerned with highway signing.

All matters pertaining to type, size, color, positioning, and use of signs are agreed upon only after considerable study by this committee, and the sev-



A sign bridge spanning both roadways of a modern freeway.

eral members observe these agreements very closely. Although this organization is advisory only, it has been very effective in securing uniformity on California roads, streets, and highways. Informal meetings of this committee are held as needed, generally several times a year.

Basic Principles and Standard Practice

Certain principles must be followed if signing is to achieve the best results in guidance and safety. One such principle is that the number of place names which can be used effectively on a single sign is distinctly limited. Except under very unusual conditions, the number should not exceed three. Because of the higher speeds on freeways, the maximum number of destinations on primary directional signs is restricted to two. Drivers of vehicles moving at present-day speeds are unable to read a long list of place names and directional arrows. Neither can they stop or slow down without hazard to traffic.

These principles are confirmed in a study by the Institute of Transportation and Traffic Engineering of the University of California which indicated that the number of drivers' errors in reading signs increases sharply if the number of names on a sign exceeds three. This study also indicated that a dividing line between destinations in opposite directions is of great benefit in reducing drivers' errors in reading signs. As a result, it has now become standard practice of the Division of Highways to use the dividing line between such destinations on new standard directional signs or replacements.

On high-standard roads, in particular, signs must be both located and proportioned so that motorists may recognize the messages, comprehend the meaning, make decisions, and direct their vehicles into the proper lane without a reduction in speed.

Reassurance Signs

To reassure motorists that they are on the right road and to tell them how far it is to points along the route, reassurance guide signs are placed facing outbound traffic at the outskirts of cities or towns and just beyond principal highway junctions. These signs generally show (1) the next town, (2) the next county seat, road junction, or important city, and (3) the end of the route. All of the towns named are on the route being traveled. Where the road divides, locations in each direction may be shown, and cities designated as the termini may be alternated on the bottom line of successive signs. Distances are shown to the nearest mile for each destination.

On interstate freeways, reassurance signs will appear at more frequent intervals, but these signs will show only two destinations, the next town and the terminal city of most general interest.

Early thinking in respect to this sign was that it did not need to be very prominent because it does not call for immediate action by the driver. Many small, nonreflectorized reassurance signs are still providing service on the older conventional highways. However, the size of the message on reassurance signs has been constantly increased in line with increases in speed and traffic volumes.







PHOTOS ABOVE—Guide signs include divider when they have destinations in different directions.

Reflectorization of this sign has been standard for some five years and size of the message on current and future installations will approach that of the major guide signs on the route.

Freeway Driving

When driving a freeway for the first time, a motorist should always consult a map to find out which exit will lead to his destination. A single exit in a metropolitan area generally leads to many city streets and destinations. Only the name of the street to which the ramp connects and one place name can be shown on the sign; so the motorist must know the name of the exit where he wants to turn off. In other words, a driver must know in advance where he wants to go if he expects to get there without confusion or mistakes.

The main purpose of highway guide signs is to tell the motorist how to reach his destination by the shortest and most efficient route. Any message on a sign which would tend to influence the motorist's decision or to encourage him to turn off the highway at a particular road or area is not within the scope of proper highway signing.

State, US and Interstate Markers

On any route, there are nearly always a great number of possible destinations and connecting highways, and it has been found impracticable to place signs along highways or at turnoffs naming all possibilities. As a statewide practice, it has been found advisable to restrict the naming of locations on a given route to those actually on the route.

Obviously, it would be impossible to place a sufficient number of signs on the highways to enable a motorist, without knowledge of the general direction or local geography, to find his way merely by looking for place names on traffic signs.

Consequently, as a matter of primary guidance, considerable use is made of state and US highway route markers. Under present-day conditions in California, a motorist unfamiliar with a geographical area needs the assistance of a road map, and road maps are readily available. Studies show that most motorists rely upon such assistance and that the route markers in



PHOTOS ABOVE—Reassurance signs are larger and reflectorized for easy nighttime as well as daytime reading.

use provide generally adequate directional information.

US Numbered Routes

The importance of a nationwide system of numbered highways was recognized in the early twenties, and the American Association of State Highway Officials (AASHO) requested the Secretary of Agriculture, under whose offices the Bureau of Public Roads at that time operated, to name a committee for the purpose of formulating a plan or system of numbered highways. The association was asked by the Secretary of Agriculture to develop such a system. This system was developed and officially adopted in 1926. The American Association of State Highway Officials is made up of all the state highway departments, those of Puerto Rico and the District of Columbia, and the US Bureau of Public Roads.

The selection of US sign routes and the assignment of numbers is a function of the Executive Committee of AASHO. Over the years, this committee has developed a set of policies for the purpose of facilitating travel on a nationwide basis over the shortest routes and best roads.

AASHO Policies

In accordance with these policies, it has been the practice of the Division of Highways to request that the best route from a traffic service standpoint be designated as the basic US route. Therefore, when a highway is reconstructed to higher standards on new alignment, either through or around a city or community, this new routing is signed as the basic numbered route.

Included in the established policies of AASHO is the provision that "No additional road shall be added to the US numbered road system, and no existing US road shall be extended except where there is a definite showing of an adequately improved highway

carrying an established and necessary line of interstate traffic not otherwise provided for by existing US routes and for which adequate traffic service cannot be provided by state route numbers.

"Extension of present US numbered routes may be made only when the proposed extension is in the general direction of the present route.

"Proposed extensions shall not be made when to do so, it is necessary to duplicate US routes already established, unless the duplication is for a short distance and the routes then diverge, ending in different terminal points."

There is obvious need for these well-established policies because designation of inadequate routes not providing the best traffic service would discredit the entire system of US numbered routes. Also, extensive or unwarranted use of alternate or business routes would result in confusion and lack of confidence in numbered routes on the part of motorists.

For the sake of uniformity, AASHO sign route policies are also followed in the establishment of California state sign routes insofar as they apply.

The route numbers are used extensively by the makers of road maps. Businesses that cater to the traveler use route numbers to tie in the location of their businesses in their advertising.

Interstate Route Numbers

The routes comprising the 41,000-mile National System of Interstate and Defense Highways are being marked with distinctive route marker shields on the basis of a numbering system that is separate and distinct from the US numbered system. The Interstate system marking and numbering is not intended to replace that of the US system, but is, in reality, a separate system of a limited mileage of modern limited access highways to accommodate traffic between the nation's major traffic generating areas, and the two numbered systems will complement each other. Much of the Interstate system is developed on new location. Those sections where the Interstate system is developed over an existing U. S. numbered route will have both the U. S. and the Interstate system shields and route numbers.



Large and prominently displayed sign directs the traveler from the freeway to the business route.

The red, white and blue Interstate shield is beginning to appear in many locations throughout the State. It is too early in the development of the Interstate system for these shields to provide an effective touring aid at the present time. However, the program is moving at a rapid pace in all states and it may not be many years before segments are connected to provide route continuity for considerable distances across the nation.

Business Districts and Business Routes

With the extension of the freeway system resulting in no businesses fronting directly on the highway, it becomes more and more important to designate to motorists where services normally required by the traveler may be found. On directional signs, this is accomplished by designations such as *central district*, *business district*, *downtown*, or *civic center*, and sometimes the name of a district or area within a city.

It is frequently found desirable to designate a "business" route on a section of former state highway which is relinquished when the community which it serves is bypassed by a new freeway. Proposed US business routes



The new large interstate shield catches the motorist's eye, but route numbers are equally readable on the smaller U.S. highway shield below.

must be submitted for approval to AASHO. These business routes are principally within the corporate limits of a city and provide the traveling public with the opportunity to travel through the business section.

In cases of this type where a business route would be of benefit to the



UPPER—Signs directing the traveler to a small community also tell him the services are available. LOWER—The inclusion of "Downtown" in the freeway signing through a major city indicates the proper turnoff to reach the central business area.

motorist, and local authorities are in accord and agree to maintain the necessary signs, it is the division's practice to recommend approval to AASHO. When a business route is approved, all directional signs on the state highway directing to the business route are installed and maintained by the Division of Highways.

The use of the business route is a convenient and logical way to direct a stranger so that he can easily find his way to the business section, transact his business, and then proceed to find his way back to the main highway by following the route shields.

The Division of Highways recognizes that the business centers of bypassed communities and along old routes provide needed services to the highway user, and every effort is made to give recognition to these business districts in a manner consistent with the principle of providing the best possible signing for all highway users.

Either overhead illuminated or reflectorized signs are installed where practicable at the connections with the road leading to the business district and the main highway. In addition, where there are other connections from the freeway to the business district, supplementary signing is also provided.

Frontage Roads and Roadside Business

When the construction of a new freeway separates developed property from the existing local road or street system and leaves no suitable connection to the freeway, it is frequently necessary to provide access to the property by construction of a local service road parallel to the freeway. This type of road is designated as a frontage road. In the case of new construction, they are parallel to the freeway. Often the old highway, or portions of the old highway, roughly parallel to the new freeway, will serve as a frontage road. Frontage roads have proven to be advantageous locations for businesses, especially those which provide necessary services for motorists.

The problem of providing adequate directional signs to roadside businesses on frontage roads or on old roads bypassed by construction of freeways developed about 1949. Signs with various wordings were considered, such as *roadside services*, *roadside business*, *roadside business area*, *roadside motels*, etc.

Roadside Business

The sign reading *roadside business* was adopted with the approval of the Motor Hotel Association of California. This sign indicates all types of services and accommodations and is consistent with our present signing practice of placing *business* signs with route markers to indicate business routes not on the main highway and providing direction to business districts.

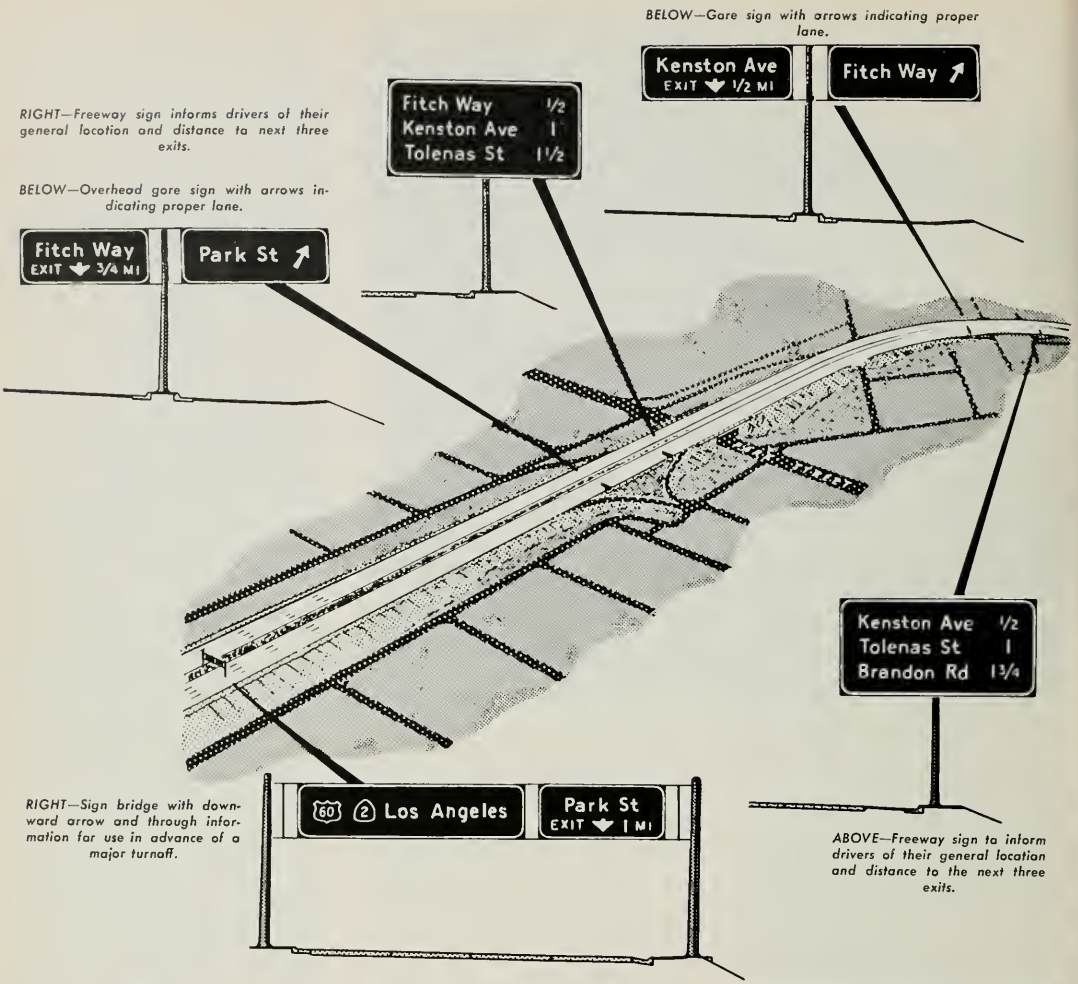
One of the important factors in the development and use of the sign reading *roadside business* was that the use of a uniform standard sign to designate these businesses would soon cause it to become known by the public. Motorists, when they recognized such a sign, would know that roadside services were available.

A survey was made by the Division of Highways Right-of-way Department on the effect of bypassing roadside business. Operators of motels, restaurants, etc., were contacted and appeared satisfied with the wording of the signs, but expressed concern regarding their placement and visibility. As a result of this survey, the signs were placed farther in advance of the intersection and the *roadside business* signs were reflectorized for night visibility.

One of the most important factors in the statewide use of uniform standard signs reading *roadside business* is that their continued and consistent use will further increase their effectiveness.

Freeway Signing

It is a long step from the first roads and streets used by automobiles to the present-day six- and eight-lane freeways in the large metropolitan areas.



BELOW—Gore sign with arrows indicating proper lane.

RIGHT—Freeway sign informs drivers of their general location and distance to next three exits.

BELOW—Overhead gore sign with arrows indicating proper lane.

RIGHT—Sign bridge with downward arrow and through information for use in advance of a major turnoff.

ABOVE—Freeway sign to inform drivers of their general location and distance to the next three exits.

Likewise, it is a long step from the early signing to that which is now required on these freeways which carry a tremendous traffic load.

Signing cannot be separated from the freeway because it is an integral part of it. Adequate signing is essential to completeness and satisfactory operation of the modern freeway. The high volumes carried by this type of facility greatly increase the signing requirements.

For example, traffic volumes which preclude changing lanes at will on the approach to an exit make it necessary



Typical freeway sign listing next three exits and their distances.



PHOTOS ABOVE—Sequence signing in advance of a freeway junction under crowded urban conditions.

to provide much greater advance notice of the turnoff. There was a time when 50 feet in advance of an intersection was adequate. Later, the distance increased progressively to several hundred feet, to one-quarter mile, to one-half mile, and now one mile or more is considered a desirable distance for the first indication of a turnoff from a freeway. This desirable distance is not always obtainable, due to limitations on design and the need for frequent connections to provide proper traffic service in highly developed areas.

Positive indications of the lane to use for different exits are very necessary. Drivers also need to know the approximate distance to the offramp they expect to use.

New System of Signing

After careful study of this problem by traffic engineers of the Division of Highways, a new system of signing for metropolitan freeways was developed early in 1956. This system has been subsequently modified in line with signing requirements on the Interstate System. The advantages of these later revisions were to develop uniformity of signing on all California freeways and attain basic uniformity with major freeway signing on a national basis. The features of the newer freeway signing most apparent to the motorist are the green rather than black backgrounds on guide signs and the upward sloping arrow at exits from the freeway instead of a down arrow over the offramp. The main features of freeway signing are:

Metropolitan Freeways

In order to inform drivers of their general location and the distance to the exit which they are seeking, signs are placed indicating the next three exits and the distance thereto in miles and fractions of miles. These signs are located as soon as practicable after passing an exit and list the next three exits. As soon as an exit is passed, its name is dropped from the top line and the second line moves up to the top position. A new exit name and distance is then added on the bottom. The names for the exits are street names, road names, route numbers, or any other name which best fits local conditions. These signs are frequent

reminders to motorists so that they will be prepared to turn off when they reach the exit that will take them to their destination.

Overhead illuminated signs are placed at exits in the gore; that is, in the triangular area between the turnoff and the main freeway lanes. These signs carry the name of the offramp, positioned directly over the offramp with an upward sloping arrow pointing in the direction of the exit movement. The other side of the sign will normally be over the outside freeway lane, and will carry the name and distance to the next exit ahead, with an arrow pointing downward to the approximate center of the outside lane. At major turnoffs, a sign bridge may be erected over the freeway lanes which will carry through traffic information in addition to the name of the next exit. The through information is usually a prominent city on the route together with appropriate route shields. Advance sign bridges carrying full information are always placed in advance of a freeway junction. With this system of signing, the names of all major exits will generally be indicated three times, at least twice on overhead illuminated signs.

Downward pointing arrows assign traffic to the appropriate lane in advance of turnoffs or branch connections. Down arrows are also used over the connecting roadways at freeway to freeway interchanges. The upward sloping arrow is now used only at the exit from the freeway and will direct to city streets or other local roads. With the complex of freeways now developing in urban areas, a high percentage of local trips will involve not one, but a system of freeways. The concept that down arrows keep you on the freeway system and an up arrow takes you off should provide a valuable aid to the motorist.

Rural Freeways

On rural freeways, overhead signs are generally restricted to gore installations at important turnoffs. They are primarily used at junctions of state or national sign routes and to direct to bypassed communities over the best connection for each direction of travel.

It was found that when a freeway bypasses a community formerly on



PHOTOS ABOVE—These signs give repeated notice of an important sign route turnoff.







PHOTOS ABOVE—Approaching a turnoff to a community from a major rural freeway, the motorist is notified repeatedly.

the sign route, and still so indicated on small-scale road maps, a considerable segment of the motorists turn off at the prominently displayed city name in the belief they are following the route. For this reason, it is now standard practice to show a prominent through destination, together with the route shield, on the left panel of a butterfly sign when the right panel directs to a bypassed community.

Although traffic volumes are usually not comparable to urban freeways, the greater speeds of rural travel make advance notice of turnoffs equally important. First notice is provided by a large ground-mounted sign carrying turnoff information in 16-inch capital and 12-inch lower case letters, together with the distance to the exit, usually one mile. Additional notice is provided by lane-indicating signs placed midway between the first advance sign and the exit. These, together with a sign at the gore, again provide three notices of the turnoff.

It is a well-known fact that drivers, through inattention or distraction, frequently pass even a prominently placed sign without comprehending it. The repetition of the exit names and lane indications should reduce this problem to the minimum.

Sign Madernization

Highway designs, including signing, are continually being improved. It is not economical or practical to go back and revise all previous designs and installations whenever a new and better way of signing is developed. However, the effectiveness of modern signing has resulted in many demands for the re-signing of older freeways. In this respect, a systematic program is now under way in which those higher traffic areas having the most critical deficiencies in signing receive the first priority for modernization.

California has taken the lead in developing overhead illuminated freeway signs and rates high nationally in the field of traffic control. Uniformity, so vitally necessary for effective signing, is obtained by an up-to-date looseleaf manual setting forth uniform standards and policies for signs and other traffic control devices used on state highways. Uniformity and adequacy of signing on California county roads and city streets is, with a few exceptions, very good, largely through the activities of the California Sign Committee.

The driver must not be left out of the picture. The best signs in the world are no positive assurance that a few drivers won't make mistakes or take a wrong turn occasionally. Drivers must take their share of the responsibility. They should study a map when using a highway or metropolitan freeway for the first time so they will know what routes to follow and where to turn off to reach their destination, and above all be alert and courteous, and follow the rules of the road at all times. Careful, competent driving, combined with safe highways and adequate traffic signs, will surely contribute substantially to smooth, safe and orderly traffic flow.

F.A.S. Expressway

First Unit of Almaden Job Is Completed in San Jose

By JAMES B. ENOCHS, Director of Public Works, Santa Clara County

In mid-November 1959, the first unit of the Almaden Expressway was opened to traffic, eliminating one of the most serious bottlenecks to the movement of traffic in and out of the City of San Jose.

The "expressway," so called to distinguish it from a full freeway, involved the construction of a four-lane divided highway and railroad overcrossing on a new alignment to bypass the existing narrow two-lane undercrossing at the Southern Pacific Railroad main line to Los Angeles.

Almaden Road has a long history, dating back to the days of the Indians when it was used as a trail to get to the area where red rocks furnished the natives with dyes to paint their faces. Later it served as a road for the early Spanish settlers (who had received land grants from the Mexican governor) to get to and from the mission and settlement at San Jose. In the period from 1850 to 1886 when the railroad was extended to the new Almaden quicksilver mines, approximately $40,000,000 in quicksilver was hauled over the road in wagons and mule trains, rendering the road ankle deep in dust in the summer and axle deep in mud in the winter, until it was graveled by the county and sprinkled in summer for its entire length.



An aerial of a section of the new Almaden Expressway south of San Jose constructed by Santa Clara County under the Federal-aid Secondary Highway Program. Note the narrow railroad underpass on the old road at the left.

First Surfacing

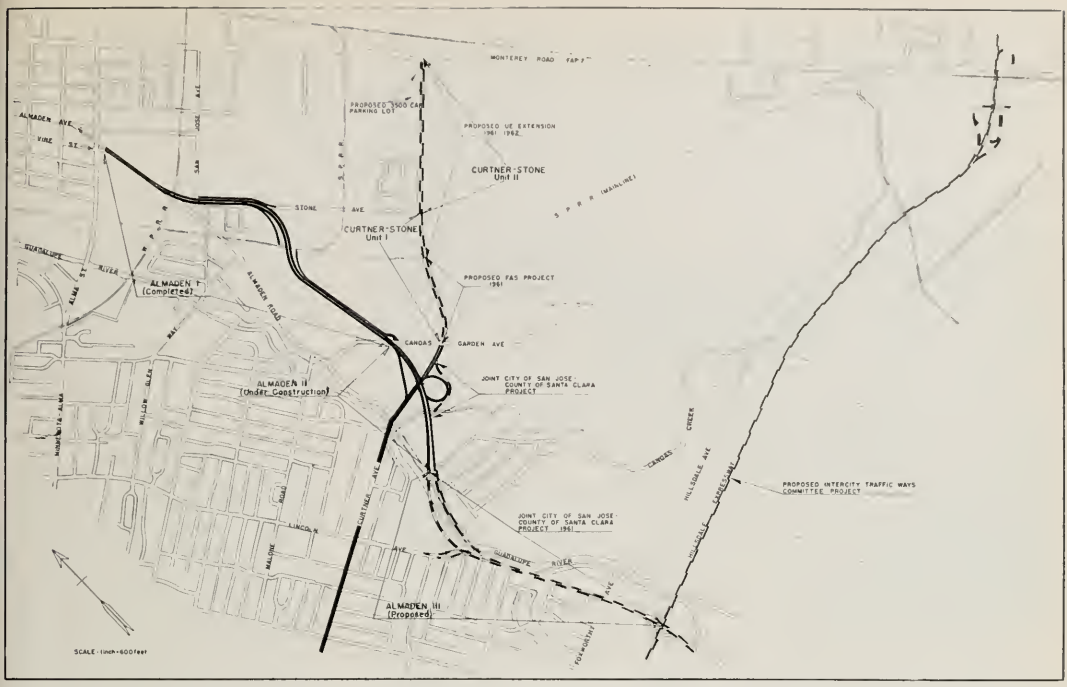
In the period 1920 to 1925 the road was surfaced with asphalt paving, and in 1935 an undercrossing was constructed at the main line of the Southern Pacific Railroad. By the early 1950's the rapid growth of the area to the south of the City of San Jose made it obvious that an alternate route would have to be constructed, or the existing undercrossing widened.

Cost studies of the alternates by the Santa Clara County Engineer's Office indicated that the bypass could be constructed for approximately $300,000 less than widening the existing undercrossing, and in 1957 planning was begun for the bypass. All agencies, county, city, state and federal, contributed funds for the project, and on November 18, 1958, a contract was awarded to Edward Keeble Construction Company of San Jose for the construction of the first unit (1.25 miles) of the Almaden Bypass. The construction cost, exclusive of right-of-way and engineering, was approximately $915,000.

The roadway section chosen consisted of four inches of plant mix surfacing over eight inches of Class A cement-treated base, over six inches of imported select material. Only two grade crossings remain, and the one at Canoas Garden Avenue will be eliminated by the construction of Unit 2 of the bypass. The other, at San Jose Avenue, a real "problem" intersection now, will be eliminated when the Curtner-Stone Extension has been completed to the Monterey Road (Highway 101). Although the expressway does not have full freeway status, the areas adjoining are served by frontage roads on both sides for almost the full length of the project.

Settlement Problem

A settlement problem, somewhat unexpected at this distance from San Francisco Bay, developed as placement of the overcrossing approach embankments progressed. Ultimate settlement of the natural ground beneath the embankments, as measured by settlement platforms was found to be approximately 2.2 feet for the northerly approach embankment, but only 1.2 feet for the approach immediately across the Southern Pacific Railroad right-of-way. The settlement subsided to zero in February of 1960, and no difficulty



A map of the Almaden Expressway project showing units already constructed, those now under construction and those proposed for future construction.

has been experienced with either the structure or the approach pavement.

The second unit of the bypass is now being constructed by Leo F. Piazza Paving Co. of San Jose under a $385,000 federal aid secondary contract awarded in December 1959 and will be open to traffic this fall. It consists of construction of a plate girder overcrossing at the Curtner-Stone Extension, construction of a portion of the Curtner-Stone Extension, and extension of the expressway approximately 0.5 mile southerly to Redbird Drive where it tapers into the existing alignment near the Guadalupe River Bridge.

Plans are being prepared by the county for unit 3 and construction work should begin on this joint Santa Clara County-City of San Jose project by mid-1961. In addition, plans for unit 4 (Curtner-Stone Extension to Highway 101) are well along, and a federal aid secondary contract will be awarded in 1961 for this link to serve the rapidly growing industrial areas along Highway 101 south of San Jose.

Application has been made to aid this Curtner-Stone project with urban extension funds as well as FAS funds.

Hillsdale Project

The only remaining project of immediate concern for this area is the connection of the Almaden Expressway with the new Hillsdale Expressway being constructed as a joint project by the City of San Jose and the County of Santa Clara to serve east-west traffic south of the city. However, it is hoped that the Almaden Expressway can be extended south to serve the area as fast as the buildup of population demands.

Design and construction engineering was done by Santa Clara County personnel under the direction of James B. Enochs, Director of Public Works. Olaf A. Bue was resident engineer on the first unit, and Jack M. Williams is resident engineer for the unit now under construction. Valuable assistance was and is being given by the California Division of Highways including the Bridge Department during the course of the project.

The excellent co-operation between the City of San Jose and the County of Santa Clara in working out mutual problems of design and construction of the four units presently contemplated for the Almaden Expressway gives hope that all political jurisdictions of Santa Clara County can join to secure a successful election in March 1961 for the $70,000,000 first stage of a comprehensive countywide expressways system.

A record high for one day of 58,520 vehicles crossed Carquinez Bridge on Sunday, August 14. This was nearly 2,000 more vehicles than crossed the bridge on the previous high day, July 2, 1960, when 56,973 vehicles were counted.

Cable Relocation

New Technique Used, Savings Total $240,000

By WARREN B. JAMES, Associate Bridge Engineer, and
A. H. MUNGER, Highway Engineering Associate



THE CONSTRUCTION of the Golden State Freeway extending from Mission Road to Pasadena Avenue, Road VII-LA-4-LA, was completed and opened to public traffic on March 18, 1960. This portion of the Golden State Freeway consists of eight lanes on new alignment 1.2 miles in length in the City of Los Angeles, and it was constructed by the contractors, J. C. Boespflug Construction Co. and J. L. McLaughlin, at a total construction cost to the State of $2,800,000.

This freeway construction included an overhead bridge structure on North Broadway, which involved an engineering problem because of the large number of Pacific Telephone cables existing in this city street. Clearing the area in advance of bridge construction would normally have required the relocation of the existing 40 underground multiple tile ducts containing 26 cables with each cable containing hundreds of wires for message transmission. In one unit there were 24 ducts 16 feet southerly of which there were two units of eight ducts each located approximately five feet apart. These ducts were on the north side of North Broadway extending across the freeway location. According to usual accepted standard practice, relocation of these telephone facilities by the "shoofly method" would have required two moves; the first being to locate in the detour roadway around the bridge and the second to place in the final location in the deck of the bridge structure.

New Technique Employed

The procedure used on this freeway contract called the "supporting in place method" departed from the old standard "shoofly method" of placing the telephone cables in a detour around the bridge construction site. The new method substituted a temporary arrangement of steel beams supporting the existing telephone cables in place until the lower slab and stems of the box girders could be constructed. Slots were left in the bridge diaphragms and abutments to permit the lowering of the ducts into final position. By this new procedure uninterrupted service of the telephone cables was maintained. The top slab of the box girders was formed and poured in the normal manner.

Savings Are Listed

Running simultaneously with the state highway contract, there was a telephone company contract amounting to approximately $60,000. The telephone company estimated that the placing, cutting-in and splicing of shoofly cables would have required approximately six months' time with an additional six months to restore the lines to normal use. This 12 months' allowance for relocation work plus normal loss of cable use during cut-overs was estimated conservatively to cost the sum of $300,000. Subtracting the $60,000 telephone contract, net savings from use of the new "supporting in place method" compared to the old "shoofly method" amounted to $240,000, of which $120,000 would have been the cost assessable to the



An overall view of the telephone ducts supported from the girders by steel straps shortly after excavation work on the bridge began.

State in accordance with existing utility relocation contract. This did not take into account money losses resulting from possible interruptions in TV, radio and other coaxial trunk line services had the "shoofly method" been employed. Of the 26 cables, three were TV, radio and long distance toll lines to the east coast and the remainder were main trunk lines between city telephone exchanges. Further, if the "shoofly method" had been used the State's freeway contractor would have had serious interruptions to his work, first while the telephone bypass cable was being installed in the detour and again during the permanent cable installation in the new bridge structure.

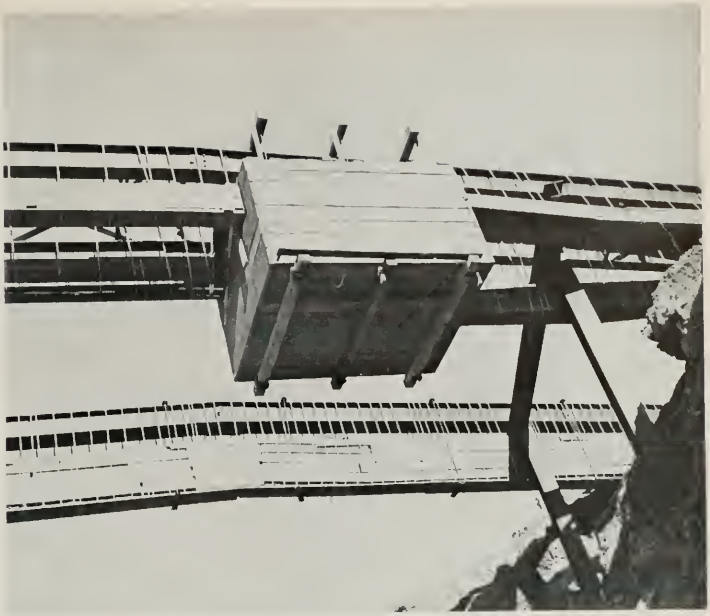
Construction Methods

The contract plans originally called for the steel beams carrying the cables to be supported on islands of earth left between cribbed excavations for abutments and piers. After study by The Pacific Telephone and Telegraph Company and under an agreement between the contractor and State, the earth islands and the cribbing for excavations were eliminated and in their place welded steel bents were erected, spaced about 20 feet on both sides of the abutments and piers. This change in contract involved a change order which resulted in a savings of $2,700 to the State. The telephone company, using its own contract forces, furnished and erected the main steel beams, and strapped the cables and ducts protected by timber plank sheeting to the beams and handled the raising and lowering of the cables.

The work performed by the State's contractor consisted of both structural and roadway excavation under the cables and in placing the temporary supports for the cables during these operations. This method of placing required that holes be drilled in the existing ground after the telephone conduit had been exposed, for placing the legs of the steel bents.

Holes Drilled

Two-foot-diameter holes for the bent legs were drilled from the surface of ground to the elevation of the bottom of the footings, a depth of approximately 34 feet from ground sur-



A view from below of the telephone manhole contents and ducts protected by timber planks and supported above the bridge "glory hole" prior to the construction of the bridge abutment.



A side view of the telephone manhole contents and ducts shown above, after construction of the bridge abutment.



A photo of the project after the falsework was constructed showing the telephone ducts supported from the steel girders.



Workers prepare to release the steel straps and lower the ducts into their final position inside the concrete girder.

face. Then 12-inch, 53-pound steel H-bearing piles were placed in the holes and the bottom 10 feet encased in concrete. The bent caps were left off temporarily until the supporting beams with the conduit strapped to them were raised to grade. The 12-inch steel bent caps were then placed to support the longitudinal beams and were welded to the legs.

The detailed construction steps employed in sequence consisted of exposing the telephone ducts containing the cables, encasing the ducts in protective timber plank sheeting, placing longitudinal 18-inch WF70 26-beam supports above the ducts and hanging the ducts and cables to the beams by means of steel straps. The I-beams were raised with jacks approximately four feet to provide a two-foot clearance between the ducts and the lower slab of the box girders. At this stage the caps of the steel bents were inserted under the I-beams and the loads were then transferred to the steel bents.

No Interference

The excavation for the abutments and piers were made using heavy excavation equipment, without interference from timber cribbing originally required by the specifications. The two abutments and the center pier were constructed in the excavation to bridge seat elevation. Short WF-beam columns to serve as legs for a second set of temporary column supports were placed in the abutments and center pier. The cable load was transferred to these column supports and the first temporary steel bents removed. The supporting I-beams were then at the maximum 75-foot span for which they were designed. After the first temporary bents were removed, the balance of the earth under the bridge was excavated. Deck falsework and forms were erected and the lower bridge slab and stems of the box girder poured.

The process of lowering the ducts and cables onto the lower concrete slab was started as soon as possible. These telephone ducts were finally placed on the lower slab while it was still supported by forms and falsework. The lowering was accomplished by employing long threaded vertical



The telephone ducts shown in their permanent position inside the concrete box girder.

bolts through yokes supporting the ducts. The ducts were anchored in their final position by partial encasement in lightweight concrete. The top slab forms of the box girder were then placed and the top slab poured.

At Bridge Abutment No. 3, a telephone cable manhole was incorporated with the abutment to give access to existing splices in the cables. This is shown in a photograph illustrating this story.

The problem of finding the required four inches of slack in the cables to allow for the four feet of vertical lift was not too difficult since some slack existed in adjacent manholes on both sides of the freeway. However, great care was exercised by the telephone company to be sure that the cables were not overstressed by pulling. The telephone company kept its own inspector on the job during the critical stages of the work, which were completed as planned without serious difficulties.

Method Is Successful

This new "supporting in place method" for taking care of existing telephone ducts during bridge construction as carried out on this job proved to be a successful construction method satisfactory for widespread use.

The vast savings in utility relocation costs further warrants the employment of this method for similar situations where a large number of telephone cables are involved with a bridge structure. The method should also be considered where a smaller number of cables are involved when it is more economical than installing an overhead line or a temporary "shoofly" installation in the bridge detour to clear the bridge construction area.

The District VII Right of Way Clearance Department staff wishes to acknowledge the co-operation of The Pacific Telephone and Telegraph Company representatives for their contribution in the successful development of this new "supporting in place method" for handling telephone cables during construction. Special appreciation is extended to Mr. William G. Cook of the Los Angeles office of the Pacific Telephone Company for his assistance.

STATE CHAMBER MAKES HIGHWAY RECOMMENDATIONS

The California State Chamber of Commerce made its annual full-dress appearance before the California Highway Commission in Sacramento on August 31, presenting the results of highway project studies in all 58 counties of the State.

The 86-page report of the state chamber's statewide highway committee was the distillation of discussions and recommendations made by local officials and civic leaders at a series of 50 meeting held throughout the State during the spring and summer.



In this view of the California Highway Commission hearing room in Sacramento on August 31st, Chairman F. W. Torr of the Statewide Highway Committee of the California State Chamber of Commerce is turning from the lectern to call on one of the regional committee chairmen to present project recommendations. Members of the Highway Commission are seated on the platform, rear of photo.

The 747 projects recommended for commission consideration were grouped into three categories, county by county: those where construction could be undertaken very shortly, those for which additional planning and rights-of-way were indicated, and those on which long-range planning should be started or continued.

Following the presentation, the Highway Commission acknowledged the state chamber group's service in the following resolution:

WHEREAS, For many years the California State Chamber of Commerce, through its Transportation and Highway Department, has annually arranged and conducted public meetings in the various counties of the State, providing an opportunity for local public officials, civic organizations and individuals to express their views and recommendations on highway matters; and

WHEREAS, This activity has become a valuable aid to the California Highway Commission in administering California's highway program; and

WHEREAS, The policy whereby a state agency, through a statewide civic organization, goes into local communities to solicit advice and guidance in the development of a state highway program is unique among states of the nation; and

WHEREAS, It is recognized that this activity of the State Chamber of Commerce is a distinct service not only to the California Highway Commission but to every citizen of California; now, therefore be it

Resolved, That the California Highway Commission commends the State Chamber of Commerce for this fine public service and by this means expresses its appreciation for the co-operation and assistance rendered by the staff and committee members in the development of this program in the public interest; and be it further

Resolved, That a copy of this resolution be sent to the officers and directors of the State Chamber of Commerce and to Edmund G. Brown, Governor of California.

Adopted this first day of September 1960 by unanimous vote of the California Highway Commission.

Bid Opening Set for Yerba Buena Tunnel

The State Division of San Francisco Bay Toll Crossings will advertise for bids shortly on a project to reconstruct the Yerba Buena Island Tunnel portion of the San Francisco-Oakland Bay Bridge.

The project is another step in conversion of the bridge to provide for five lanes of one-direction traffic flow on each of its two decks.

A total of approximately $4,000,000 in Bay Bridge revenue funds is available for the tunnel reconstruction work. Bids will be opened at 2 p.m. on October 11, 1960, in the division's office at 151 Fremont Street, San Francisco.

The project involves removal of the Key System rails on the lower deck through the tunnel; lowering the level of the lower deck, one-half the deck width at a time, in order to maintain continuous traffic flow; removal of the center columns supporting the upper deck through the tunnel; and then lowering of the level of the upper deck.

The level of the upper deck must be lowered 16 inches throughout the tunnel, it was explained by Norman C. Raab, Division Chief, in order to accommodate the trucks which will be using the upper deck as well as the lower when the whole reconstruction job is completed.

The upper deck will be lowered without noticeable interference with traffic by means of specially designed movable ramps, Raab explained.

The project will also involve revision of electrical, mechanical and other facilities and the construction of bus lanes and passenger platforms on both upper and lower decks.

Special Body Made for Profilograph Truck



PHOTO LEFT—Among the 8500 equipment units administered by the Division of Highways Equipment Department are many requiring specialized design and construction. The component parts of these units are manufactured by the Department in its Headquarters Shop in Sacramento. They are not available on the open market.

Such a unit is a special body mounted on a 1-ton truck between the truck chassis and a surveyor's type body. This body was built for the Materials and Research Department for special use in connection with studies of pavement smoothness.

Deflectometer

Semiautomatic Unit Speeds Surface Deflection Measurement

By F. N. HVEEM, Materials and Research Engineer

ENGINEERS must think about or take into account many different phenomena relating to the behavior of the things they build, and among these is the question of how much movement occurs when a material or structure is under load. Most engineering works are required to sustain loads or resist forces, but in the process of sustaining these loads virtually all structural members yield or deflect slightly. Thus, tall buildings sway or bend under high wind pressures and the floors of buildings and decks of bridges deflect and rebound measurably under moving wheel loads.

Movement under transient vehicle loads is not confined to bridges as it can be shown that all highway pavements deflect under heavy axle loads to a greater or lesser degree depending upon several factors or conditions. One common factor is the magnitude of the load, but there is another variable that influences the deflections of pavements that is not involved in bridge decks; namely, the nature of the underlying support. A bridge deck must be strong enough to carry the design loads across the span between piers or abutments, but pavements are not expected to span any appreciable distance or area and therefore the nature of the subgrade support becomes a major consideration when studying the performance of pavements under load.



Figure 1. Fatigue cracks, generally known as "alligator" cracks.

Established Procedure

The design of a reinforced concrete or steel beam which will sustain a given load is a well established engineering procedure, and here the strength elements are confined solely within the beam. While many engineers regard a highway pavement as a sort of "beam" actually the pavement itself is no more than the upper layer or "crust" of a "beam" which is of considerable depth but with no clearly defined lower boundary. The

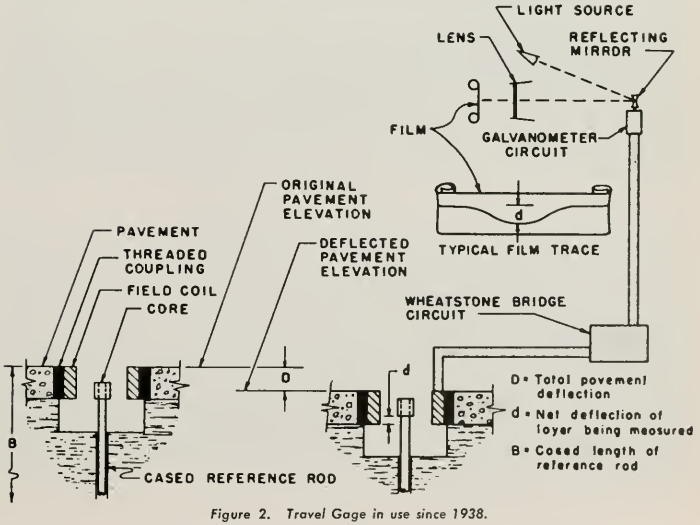


Figure 2. Travel Gage in use since 1938.

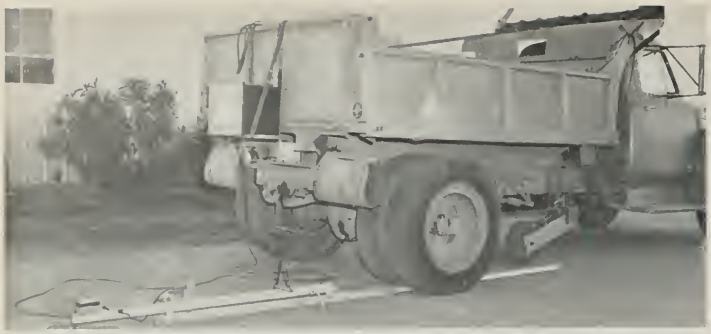


Figure 3. Benkelman Beam used under a loaded truck wheel. The recorder and odometer wheel were added by California.



Figure 4. Traveling Deflectometer.



Figure 5. Traveling Deflectometer: In the recording cycle the probes and their traverse assembly remain stationary on the road while the truck moves forward.



Figure 6. Traveling Deflectometer: The traverse assembly is picked up by a pneumatic operated track and carried ahead and dropped on the road to repeat the cycle.

amount of deflection which the more or less hard and brittle upper layer must undergo as the underlying soil is compressed with each passing wheel load is a matter for concern as sufficient alternate bending and flexing will ultimately lead to cracking of the pavement surface. These cracks are of the type known as fatigue cracks, Figure 1.

The measurement of pavement deflections has been carried on in California for a number of years. In 1938, the laboratory secured a General Electric travel gage which was used in investigations both on state highways and on airfield pavements during the war years. In 1951, an organized study of California pavements was undertaken and results reported.* This instrument still remains one of the most accurate methods for measuring pavement deflections, Figure 2. It has the disadvantage, however, of requiring considerable time and expense for the installation of units as five-inch diameter holes must be drilled in the pavement, and cased reference rods driven to the desired depth.

Device Is Developed

During the operation of the WASHO test road in Idaho, A. C. Benkelman developed a device, Figure 3, now known as the Benkelman Beam, which makes it possible to measure the surface deflections of pavements without the necessity for cutting holes and installing gaging units. The use of the Benkelman Beam has speeded up the process of measuring pavement deflections. However, the measurement of deflections over a long stretch of road is still a relatively slow process, and in order to obtain a greater amount of data for a given expenditure of time the Materials and Research Department has developed a semiautomatic device called the traveling deflectometer. This instrument is shown in Figures 4, 5, and 6. The principle is illustrated by the sketch, Figure 7. The deflectometer combines a truck trailer unit which carries the test load on the rear wheels of the trailer with means for measuring the pavement deflections under both

* "Pavement Deflections and Fatigue Failures," Highway Research Board Bulletin 114 (1955) By F. N. Hveem.

wheels simultaneously. Essentially, this is an electromechanical device capable of measuring pavement deflections under a single axle wheel load at 12½-foot intervals uniformly and continuously as the vehicle moves steadily along the roadway at one-half mile per hour. The deflections are measured to the nearest 1/1000 inch by means of a probe arm resting on the pavement, Figure 8, and permanently recorded on chart paper. (To visualize the sensitivity of this instrument, an ordinary cigarette paper is 1/1000 of an inch thick.) The load on the semitrailer may be readily shifted from front to rear, thus making it possible to vary the axle load from 12,000-lb. to 16,000-lb. simply by means of a switch in the control cab. The great advantage of this deflectometer is that it can be used to quickly scan random spots on long stretches of roadway or make measurements at close intervals where desired.

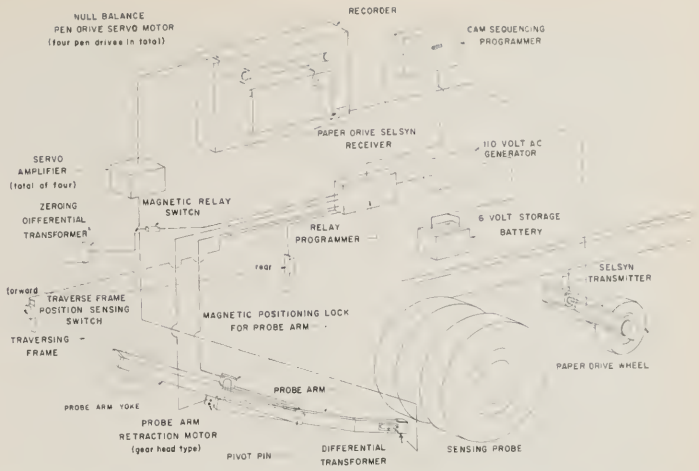


Figure 7. Schematic arrangement of the deflection sensing and recording system.

Purposes Outlined

It is expected that the traveling deflectometer will be useful for the following purposes:

1. To check the condition of lightly constructed highways during the spring wet period or "spring breakup" in order to judge whether load restrictions should be imposed during the time when the pavements are susceptible to damage. (Many highway departments in the northern states have been forced to ban heavy traffic during the critical period to protect the public investment, but the problem of producing test data to prove that a given pave-



Figure 8. Sensing probe being straddled by dual tires. The truck drives at a constant speed near ½ mile per hour. After being passed by the wheel the probe is automatically lifted and traversed farward to take readings at 12-foot intervals.

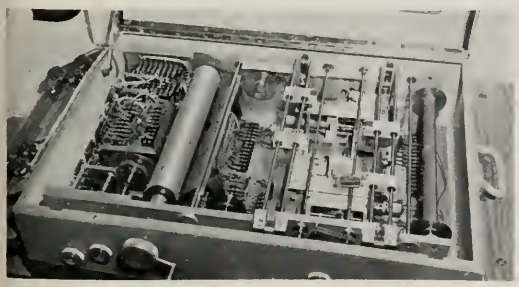


Figure 9. Chart recorder constructed for the Deflectameter. Space for four recording pens on the right. Manual controls on left of console.



Figure 10. The working parts of the recorder exposed. This unit can record four sets of deflectar measurements in one operation.

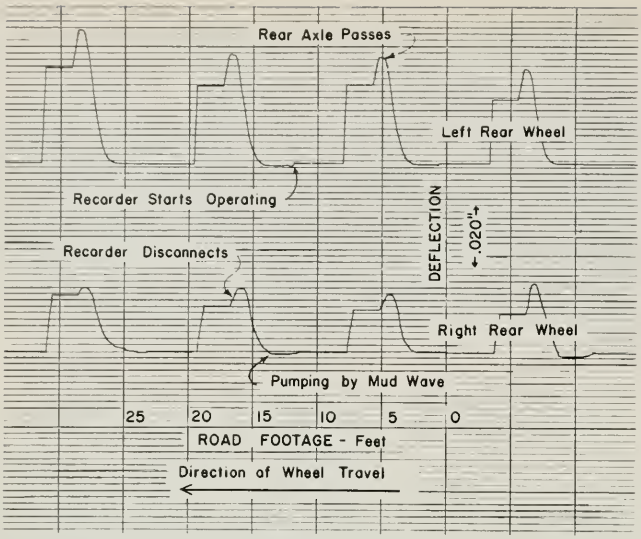


Figure 11. Trace produced by the Deflectometer recorder showing action under both wheels of the loaded trailer. The chart paper feeds from the right. Thus, compared to most graphs, this chart is read backwards. The operational cycle starts about five feet ahead of the axle and, as the dual wheels approach and straddle the sensing probes, a slight plastic heave may precede the downward deflection of the pavement. The deflection continues due to visco-elastic effects until the tire lifts from the pavement, at which time elastic rebound occurs. The right angle "step portion" of the curve is produced by the automatic zero reset and does not represent any movement of the pavement.

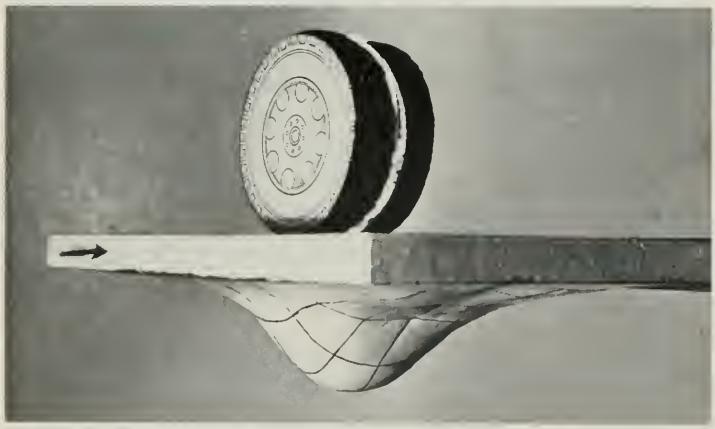


Figure 12. Model showing typical deflection of a flexible pavement under a heavy wheel load. Deflection is about 0.020". The vertical scale is greatly exaggerated on this model.

ment is vulnerable has always been most difficult.)

2. Evaluate existing roadways, both pavements and shoulders, to determine whether reinforcing or overlays are necessary and, if so, what thickness of surfacing may be required. The use of deflection measurements will enable engineers to plan maintenance and reconstruction work more precisely.
3. Permit a periodic checkup on existing pavements so that potential distress may be anticipated. A careful analysis of roadway deflections will make it possible to predict whether or not distress is imminent unless remedial action is taken.

Can Determine Length

Figures 9 and 10 are pictures of the chart recorder. Figure 11 shows some of the deflection records obtained with this instrument. It will be noted that it is possible to determine the length of pavement which is involved in the "deflection area." Figure 12 is a photograph of a model constructed to illustrate the shape of a typical depression under a wheel load on an asphaltic pavement. The length and depth of this depression varies with local conditions and the deflectometer trace indicates both the length of the axis of the oval-shaped area and the maximum depth of the depression.

The deflectometer was designed, developed and constructed jointly by the Materials and Research Department and the Headquarters Equipment Department. The trailer, load-shifting device, cab, etc., were constructed in the equipment shop. The sensing elements, electronic units and circuits were designed by laboratory personnel and constructed in the laboratory shop. Many individuals have been associated with the design and construction among whom are L. S. Hannibal, Senior Mechanical Engineer, and J. C. Eagan, Assistant Physical Testing Engineer. R. E. Wilhelmy supervised all of the machine shop work.

PROGRAM EXCEEDS $115 MILLION

The state building program of the Division of Architecture will exceed $115,000,000 during the fiscal year July 1, 1960, through June 30, 1961. The program is divided into $74,000,000 of Northern California projects and $41,000,000 of Southern California projects.

This is a reversal of trend in the division of work which a year ago was divided about equally between the two areas. Principal reason for the increase in Northern California is because of several major building programs.

Treated Subgrade

Smoothness, Uniformity Key To Good Slip-form Paving

By JAMES L. NEEDHAM, Senior Resident Engineer



THE CEMENT treatment of subgrade under portland cement concrete pavement is not a new idea. Its value and long-range economy have been and are being proven through the performance of roadways under severe conditions of traffic and climate. The methods of construction of cement treated bases and subgrades have been covered in articles in previous issues of *California Highways and Public Works* with particular reference to the article by Earl Withycombe in the July-August 1951 issue.

With the advent of the use of slip-form paving methods for placing portland cement concrete pavement, some new problems have been added to those already existing in the cement treated subgrade operations. This discussion is confined to that particular operation, and a description of what was done on a recent contract in District VII.

This project is being constructed by the Guy F. Atkinson Company with C. R. "Duke" Fowler as superintendent. It is located on US 101 in Orange County between 1.4 mile south of Sign Route 74 at San Juan Capistrano and Avenida Ramona in San Clemente. It is 7.77 miles in length and the approximate cost will be $6,200,000.

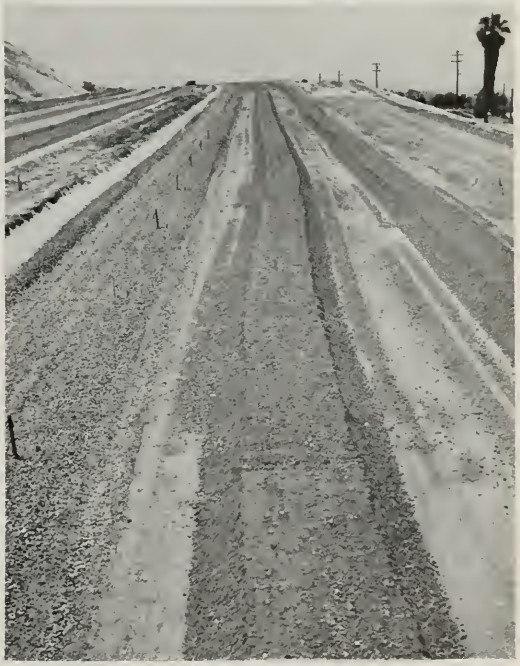
Paver Used

Portland cement concrete pavement was placed with a slip-form paver of the type that travels on the completed subgrade and places a specified thickness of pavement thereon. Its operation and the comparative results obtained have been described by R. I. Innis in his article in the May-June issue of this magazine.

The material to be cement treated on this contract consisted of untreated base material, 1½-inch maximum size, which was obtained from a commercial source near the job. The contract plans and specifications



Automatic road building machine cuts subgrade on untreated base. Stakes carrying the grade wire are on the left in front of the machine.



This photo shows sized windrows of untreated base material for four-inch-thick layer of cement treated subgrade.



Construction on the San Diego Freeway (US 101) between San Clemente and Capistrano. Comino de Estrella overcrossing is in the foreground.



Construction on the San Diego Freeway (US 101) between San Clemente and Capistrano, looking northwest toward Capistrano.

called for an eight-inch layer of this base material under the concrete pavement with the top four inches to be cement treated. The requirements of the Standard Specifications covering the use of side forms were modified by contract change order to permit the use of slip-form paving methods. The contractor elected to place the upper four-inch layer of material in windrows, cement treated by road mix methods and then spread and compacted to a specified grade and cross section.

In order to insure that required thickness of the completed cement treated subgrade will be maintained true to grade and cross section, it is necessary that a very accurate grade be made on the top of the first four-inch layer of untreated base material prior to placing the windrows of material to be cement treated. Grade stakes, referenced to the finished surface of the completed cement treated subgrade were set on five-foot offsets from each edge of pavement on the initial 24-foot width placed by the slip-form paver. These stakes were set at 50-foot intervals on tangents and at 25-foot intervals on horizontal and vertical curves. A minimum width of 26 feet was cement treated in order to provide a transition from the riding area to the shoulder.

Subgrade Is Cut

The contractor used an automatic road building machine to cut the sub-



A cement distributor truck spreads cement on a windrow of untreated base material.



Cement treated subgrade operations showing the road mixing and the initial rolling.



Cement treated subgrade in the vicinity of the Avenue Pico Undercrossing ready for placing of a 24-foot width of portland cement concrete pavement.

grade on the top of the bottom four-inch layer of untreated base material and the five-foot offset for placing of stakes was chosen to accommodate this machine. This is a comparatively new machine which is being developed for construction work.

The top four-inch layer of untreated base material was placed in two windrows of predetermined size on the prepared subgrade by means of a spreader box.

Cement was added to the windrowed material by means of a bulk cement distributor truck, equipped with a metering device, to accurately control the amount of cement discharged.

Mixing was accomplished with a road mixer operating on the subgrade.

The mixed material was then spread to grade and cross section and thoroughly compacted. A motor grader equipped with an automatic blade control device was used for the final spreading and trimming operation with steel wheel tandem and pneumatic-tired rollers being used for compacting to the required density.

Smooth Subgrade Best

Now, let us again consider the slip-form paver. The machine used on this contract operates directly upon the surface of the cement treated subgrade. The smoothness of the pavement is almost directly proportional to the smoothness of the subgrade under the tracks of the paving machine. Variations in the subgrade are reproduced in the pavement surface. It can therefore readily be seen that it is important to obtain a smooth, uniform grade, particularly in the track paths of the slip-form paver. The subgrade must also be true in cross section between the track paths of the paving machine, without any crown, because high subgrade will result in less than minimum permissible thickness of pavement.

During the process of spreading the cement treated material with motor graders to hubs or stakes set to finished subgrade elevation, a wavy or undulating grade line is usually developed. Profilograph readings taken on the completed subgrade show that this condition exists, with the length of the waves or undulations conforming to the staked grade points. The maximum variation occurs at the edge of the cement treated subgrade over the hub or stake line. If these waves or undulations are very large, they will show as excess roughness in profilograph readings.

Profile Index

Contract specifications required that the profile index of the completed subgrade as measured by the profilograph in accordance with methods in use by the Materials and Research Laboratory of the Division of Highways, should not exceed the rate of 10 inches per mile for any one-tenth-mile section along any line parallel to the edge of pavement. Any deviations which produced a greater profile index rate were reduced by additional trimming.

The profilogram obtained on the completed subgrade was used to locate rough spots and holes in the track paths of the slip-form paver. These spots were then smoothed out by padding with a dry pack mixture of sand and cement to provide a uniform surface for the tracks of the paving machine.

The care and precision with which this padding operation was done was immediately reflected in the smoothness of the concrete pavement placed by the slip-form paver.

Much of the grade line control previously obtained by the use of side forms for concrete paving and cement treated subgrade operations is no longer present in slip-form paving methods.

Westside Freeway

*A Progress Report on Interstate Planning **

By GEORGE LANGSNER, Assistant State Highway Engineer, and
M. E. CORNELIUS, Assistant Project Engineer

INTERSTATE Route 5 is the most westerly north-south highway which is to become a part of the National System of Interstate and Defense Highways (Plate 1). Interstate Route 5 (including 5E) will span California from south to north from the Mexican border south of the City of San Diego to the Oregon line north of the City of Yreka, a distance of 796 miles.

From the Mexican border through San Diego to Los Angeles, this Interstate Highway will follow portions, or relocations, of US 101. Through Los Angeles and over the Tehachapi Mountains to Wheeler Ridge at the south end of the San Joaquin Valley some 40 miles southerly of the City of Bakersfield, it will follow US 99. At Wheeler Ridge, Interstate 5 leaves US 99 to follow new alignment for approximately 315 miles until it joins US 99W near the City of Woodland about 2.0 miles northwest of Sacramento. From Woodland north to the Oregon line, it will be on US 99W and US 99, or their relocations.

This paper is confined to those portions of Interstate Route 5 in California which are on completely new alignment between Wheeler Ridge on US 99 south of Bakersfield to Woodland northwest of Sacramento. As this road will traverse the west side of the San Joaquin Valley, it is known locally as the Westside Freeway.

Route Adoption Status

In California, the legislative description of a route is quite general; it defines the route termini, with possibly one or two intermediate controls. The California Highway Commission, an appointive seven-man body serving fixed terms, under powers delegated by the Legislature, adopts the location of State Highway routes between the designated termini. The State Highway Engineer and his staff are advisers on route matters to the California Highway Commission.

The long-established route adoption procedure of the California Highway Commission conforms to the require-

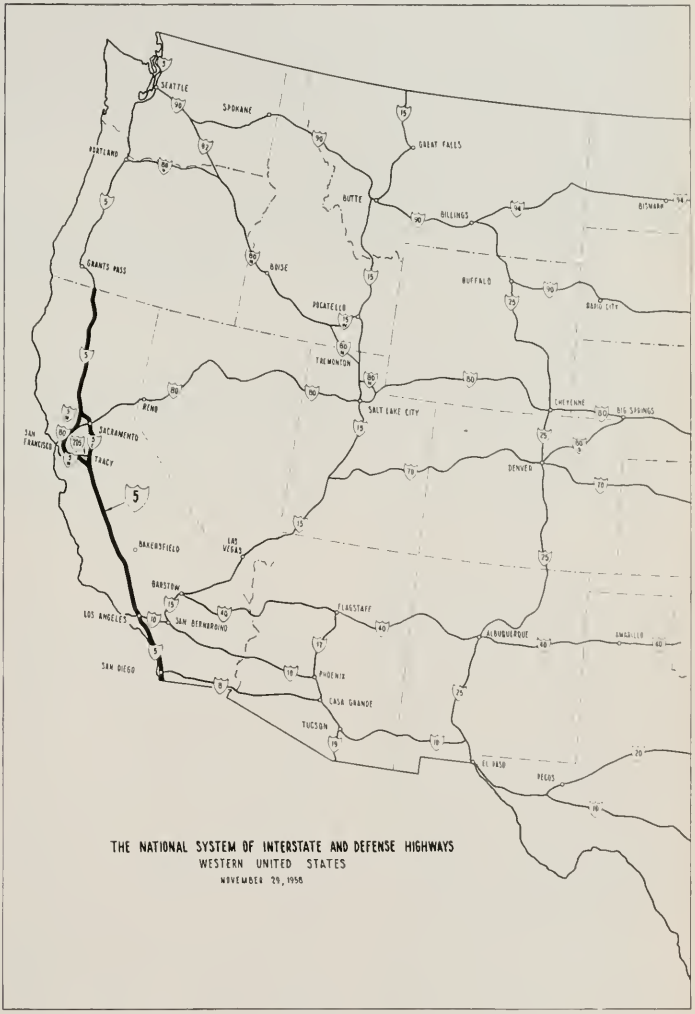


Plate 1. Interstate Route 5 is the most westerly north-south route in the National System.

* This paper was presented at the Reno Convention of the American Society of Civil Engineers Highway Division Session June 23, 1960.

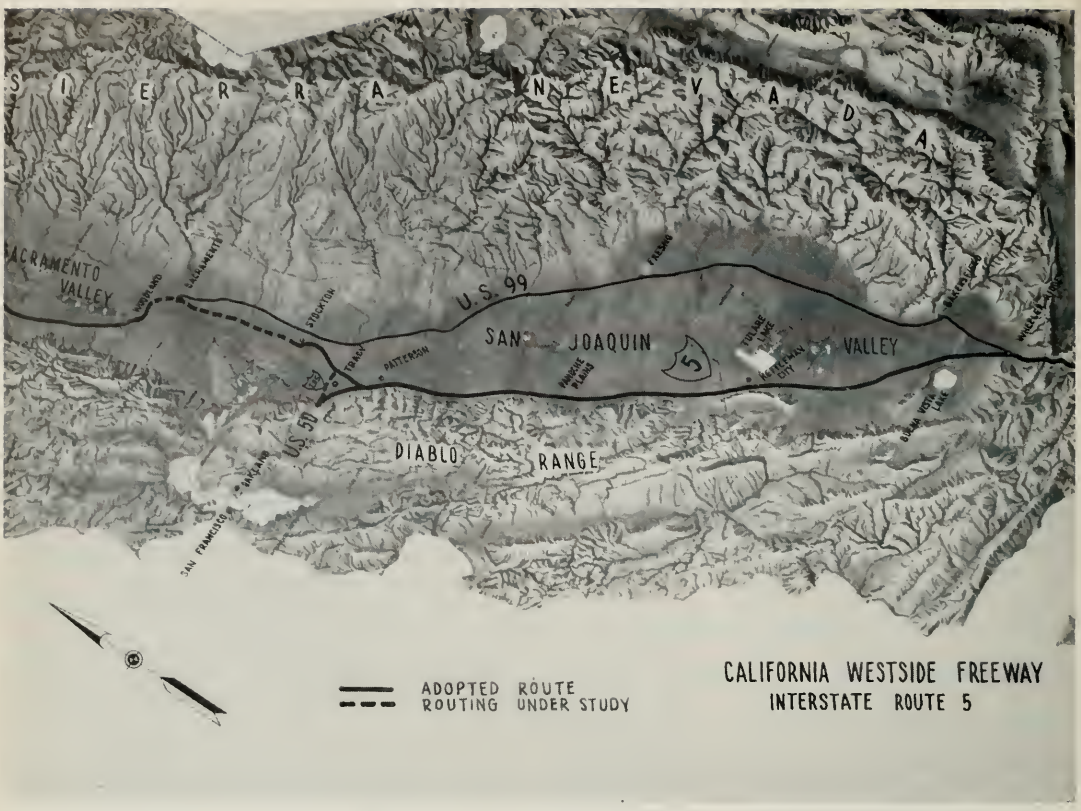


Plate 2. The California Highway Commission has adopted 256 miles of the Westside Freeway from its south terminus near Wheeler Ridge to just north of Stockton.

ments of the 1956 Federal Aid Highway Act. Briefly, it calls for conferences with local technical and planning staffs prior to and during route studies; well-publicized public meetings at which pertinent data are presented and on which comments are made by local people; a recommendation to the commission by the State Highway Engineer for adoption of a route and its declaration as a freeway; consideration of the recommendation by the commission and the notification to local governing bodies that the route is before the commission; and, finally, the holding of a public hearing by the commission if requested by a city council or county board of supervisors or on the commission's own motion. After a hearing, if held, and further consideration the commission adopts the freeway route.

Meetings Are Held

As of June 1, 1960, nine well-publicized public meetings have been held on the locations for the Westside Freeway. Preceding these public meetings, public information meetings were held with local governing bodies and interested local groups together with public displays of maps showing the numerous alternates considered. The map displays were shown at most of the incorporated cities located along or near the alternates under study. Following these public meetings, three public hearings were held by the California Highway Commission on portions now adopted.

As of June 1, 1960, the commission has adopted 256 miles of the Westside Freeway from its southerly terminus near Wheeler Ridge to just north of the City of Stockton (Plate 2). It also has adopted 16 miles of the routing of the connection for Interstate 5W to existing US 50 west of Tracy, which connection is considered a part of the Westside Freeway. Present indications are that the commission should be able to consider adoption of an additional 32 miles of the Westside Freeway between Stockton and south of Sacramento sometime late in the summer or early fall of 1960. The next 20 miles through and adjacent to the City of Sacramento is under study. The last seven miles of this freeway to its terminus at its junction with US 99W near Woodland has been adopted.

Future Traffic

Most of the travel through the San Joaquin Valley presently passes through the largest cities in the valley, which are on US 99. The anticipated



Plate 3. The anticipated 1975 average daily traffic which will be using US 99 after the Westside Freeway is completed is shown above.

1975 average daily traffic which will be using both facilities after the Westside Freeway is constructed is shown on Plates 3 and 4. Both US 99, sometimes called the Golden State Highway, and the new Interstate 5, the Westside Freeway, are necessary to provide the additional traffic capacity needed through the valley to keep pace with the population growth and agricultural and industrial development of California.

When the Westside Freeway is completed, it will afford a substantial distance savings to through traffic. For travel between the San Francisco-Oakland metropolitan area and the Southern California metropolitan area, the approximate distance savings of the Westside Freeway over use of US 99 and US 50 will be 20 miles and over use of US 101 will be 43 miles. Between Los Angeles and Sacramento the driving distance will be reduced six miles over the present US 99.

The distance savings to through traffic which will be afforded by the Westside Freeway, combined with the rural character of the route, will encourage its use by heavy through trucking. Studies indicate that approximately 25 percent of the traffic on this route will be trucks, with 60 percent having five axles.

First Study

The first formal overall study of a route similar to the Westside Freeway was made in 1950, in response to a directive of the Legislature that the Division of Highways investigate the feasibility of a toll road between Los Angeles and San Francisco to be financed by the issuance of toll revenue bonds. The division's report to the Legislature concluded that a toll road between Los Angeles and San Francisco was not financially feasible at that time. Primarily, this was because such a toll road would be faced with the competition of free parallel routes which were being converted to freeways.

The data accumulated during this toll road study proved helpful when the division was directed by the 1956 Legislature to investigate the feasibility and cost of constructing a high-speed highway on the west side of the San Joaquin Valley between Woodland and the Grapevine (the Grapevine Grade at the south end of the valley). This report concluded that such a highway was feasible and would cost approximately $261,000,000. The 1957 Legislature then added the route to the state highway system. Immediately, the division commenced detailed route location studies to determine highway user costs and savings, construction costs, and pertinent community factors on various alternates for the California Highway Commission's consideration in determining the precise location.

Location Controls

The relief map, Plate 2, illustrates how the Westside Freeway fits into the topography and shows the location which the commission has adopted from Wheeler Ridge to north of the City of Stockton.

From the south end of the new alignment at Wheeler Ridge to near Patterson, about 35 miles south of Stockton, the location problem was



Plate 4. The anticipated 1975 average daily traffic which will be using the Westside Freeway following its completion is shown above.

one of selecting a route for but one major highway. From Patterson north to Stockton the problem was one of determining the best plan for a system of interstate and state highways in a large area centering about the City of Tracy. Through the City of Stockton the problem was one of selecting a routing which would fit into an overall transportation and master plan for the City of Stockton. The remaining routes from Stockton through Sacramento are under study. The varying nature of the route location problem necessitated a route location study for each of these three general areas.

The Diablo Mountain Range, shown on Plate 2, serves as a westerly control in the vicinity of Patterson and in the areas northerly and southerly of the Panoche Plains. It also illustrates the location of the Kettleman Hills, westerly of Kettleman City, which are an important terrain control. From Kettleman City south, the flood beds of the Kern River, of which Buena Vista Lake and Tulare Lake are a part, influenced the route location.

Various Routings

Most of the various routings and combinations of routings which were studied from Patterson south are shown on Plate 5. The Diablo Mountain Range and the Crows Landing Naval Air Station, just south of Patterson, restricted the routing selection to a narrow corridor in this area. The Diablo Range is also a westerly control in the area southerly of Los Banos, and in the area northerly of Coalinga. The Kettleman Hills previously mentioned lie between Kettleman City and Avenal. The Kern River headwaters in the Sierra Nevada Mountains north and easterly of Bakersfield and its channel passes just north of that city. In seasons of flood the Kern River empties into Buena Vista Lake, located some 25 miles southwesterly of the City of Bakersfield. When Buena Vista Lake fills and overflows the waters flow northward through a broad flood channel to Tulare Lake, easterly of Kettleman City.

The direct routing alternate designated as Line 1 would require approximately 29 miles of six- to eight-foot high embankment to cross this flood plain. The Line 4 alternate which passes closer to the town of Lost Hills requires like embankment construction for only four miles to cross the flood plain and is 0.3 mile longer than Line 1. All factors considered, Line 4 is the most economical location between Wheeler Ridge and Kettleman City and is the route adopted by the California Highway Commission. Other lines and combinations that were studied are also shown on this plate.

Other Factors

While the mountains and inundation areas already mentioned were major physical controls, there were other factors which influenced the determination of the route adoption. Among these factors were: (1) the location of existing major utility lines; (2) the projected location of the future Feather River Aqueduct to Southern California; (3) shallow subsidence areas; and (4) the local economy of the area traversed.

Numerous large oil, gas and power transmission lines parallel the general routing of the Westside Freeway along the west side of the San Joaquin Valley. These facilities present no unusual problems but quite naturally influenced the detailed position of the routes studied in many areas to minimize utility relocation.

A major and fundamental part of the California Water Plan is a proposed canal along the west side of the San Joaquin Valley for the transport of Feather River water to the lower San Joaquin Valley and to the metropolitan areas of Southern California. Engineering responsibility for this facility rests with the California Department of Water Resources.

The Division of Highways of the Department of Public Works and the Department of Water Resources have co-operated closely in the location and design studies for both the Westside Freeway and the Feather River Canal so as to minimize conflict, cost and right of way damages where the two facilities will be close together. Land acquisition by one agency for both facilities will be done wherever possible.

Subsidence

Because the freeway alignment is not controlled by grade in relatively flat terrain, the Division of Highways can avoid much of the subsidence problem which is of great concern to the Department of Water Resources in areas such as the Panoche Plains. Referring again to Plate 5 the westerly swing of the adopted line (Line 4-B) through the Panoche Plains area was made to skirt irrigated lands in this area of known subsidence.

There are two types of land subsidence which have occurred and are

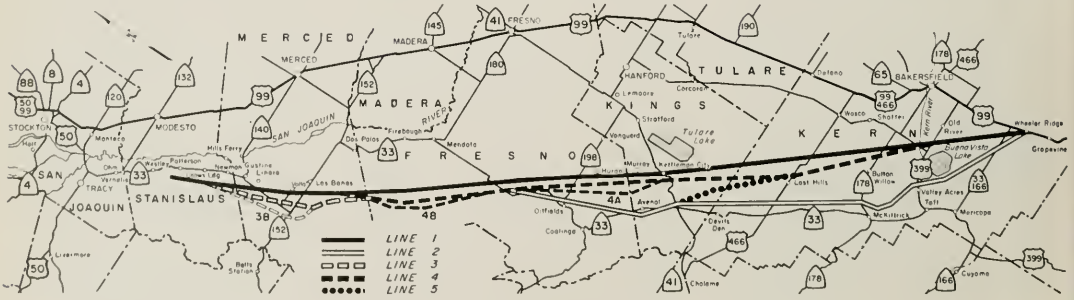


Plate 5. The various routings and combinations of routings which were studied from the Patterson area south are shown above.



Plate 6. The Department of Water Resources subsidence test pond after 14 months of operation.



Plate 7. The Department of Water Resources subsidence test plot after six months of operation.

occurring in the San Joaquin Valley.* One type is known as deep subsidence and is occurring because of the continuing extraction of ground water from below the water table. This type of subsidence affects a large area and is quite gradual. The second type, shallow subsidence, occurs above the water table and progresses from the ground surface down. It is relatively more localized and results from the consolidation of loosely compacted native soils above the water table by the addition of surface water.

The native silts of the Panoche Plains have been deposited in such a loosely consolidated natural state that they readily consolidate upon application of water. The two photographs of Plates 6 and 7 illustrate the nature of shallow subsidence. These pictures are of subsidence test plots of the California Department of Water Resources. The first photograph is of a test pond after 14 months of operation at which time the vertical displacement was more than nine feet. The second photograph is of a test plot six months after water was added to the vertical reservoir pipe just visible in the bottom of the subsidence hole.

Subsidence Phenomenon

The two photographs of Plates 8 and 9 illustrate this subsidence phenomenon when it is induced by more "natural" causes. The subsidence observed in the upper photograph resulted from the flow of water in the now abandoned irrigation ditch delineated by the row of trees. The lower photograph illustrates the subsidence occasioned by surface irrigation of the land on the right. When this photograph was taken the field to the right had been under surface irrigation for four seasons. The five-foot difference in elevation noted in the photograph is due only to shallow subsidence—no land leveling or earth removal by man was done.

Shallow subsidence in the Panoche Plains area is a problem of considerable magnitude which the staff of the Department of Water Resources is now solving. The Division of Highways is somewhat more fortunate. By bowing the Westside Freeway to the west so as to be higher and closer to the foothills across the Panoche Plains, most of the areas of known shallow subsidence could be avoided. The California Highway Commission adopted this location. Wherever the freeway is not entirely clear of suspected subsidence areas, additional width of right-of-way will be purchased so as to increase the distance from the roadway when and if the adjacent lands are brought under irrigation.

Agricultural Economy

California leads the nation in the value of agricultural products produced. $3.6 billion in 1959, the eight

* An interagency committee to study land subsidence in the San Joaquin Valley was established in 1954, representing:
(a) Federal Agencies
Bureau of Reclamation, Geological Survey, Coast and Geodetic Survey, Corps of Engineers, U. S. Soil Conservation Service.
(b) State Agencies
California Department of Water Resources, California Department of Public Works—Division of Highways.
(c) Universities
University of California—Davis, Stanford University.



Plate 8. Shallow subsidence occasioned by a new abandoned irrigation ditch.



Plate 9. An example of shallow subsidence due to surface irrigation.



Looking east toward Stockton. The adopted routing for the Westside Freeway is shown by the superimposed line.



Adopted Westside Freeway routing. Looking north from the junction of Lassen Avenue and Avenal Cut-off Road.

counties through which the Westside Freeway passes, $995 million. The San Joaquin Valley contributes more to the State's total than any other agricultural region of the State. The diversified crops which are grown on the irrigated lands of the central valleys of California include many varieties of vegetables, fruits, melons and seed crops, as well as staples such as cotton, grains, alfalfa and other feed crops. The counties of this area are also heavy producers of livestock, meats and dairy products. The following tabulation indicates the importance of agriculture in the counties which are traversed by the Westside Freeway:

County (south to north)	*Value of agricultural production (1959)* *	*State rank * (58 counties)*	*National rank * (3,102 counties)*
Kern	$210,000,000	2	2
Kings	72,000,000	15	21
Fresno	260,000,000	1	1
Merced	93,000,000	12	17
Stanislaus	126,000,000	7	9
San Joaquin	125,000,000	5	6
Sacramento	55,000,000	19	31
Yolo	54,000,000	20	35

* Data furnished by the California State Department of Agriculture.

The adopted route across the Panoche Plains also kept at a minimum the area of developed and irrigated lands to be taken or severed by the freeway.

The long westerly swings in the adopted line west of Los Banos and east of Coalinga were made to reduce the effect of the freeway on the agricultural economy in these areas.

These two line swings added 0.7 mile and 0.5 mile respectively to the travel distance through the San Joaquin Valley partly compensated for by a slight reduction in overall estimated initial cost. These line swings are in areas where the proposed Feather River Canal is not expected to bring on development through irrigation of lands lying westerly of presently irrigated lands.

Skirt Agricultural Areas

The limits of irrigated lands indicate the relation between the adopted route and the westerly limits of agricultural lands. The decision to skirt these agricultural areas was influenced by a study of the effects of these factors on the economy of the region

made by the division's Right-of-Way Department.

The many factors that were considered during the route location studies which preceded route adoptions in the Tracy and Stockton areas and which are being considered in the route location studies from Stockton through Sacramento to Woodland will be discussed briefly. In the complex Tracy and Stockton areas the various traffic desires were determined and considered along with the varied physical features; such as the location and size of navigable waterways in the San Joaquin-Sacramento Rivers Delta area, the ship turning basin at the Port of Stockton and the location of military installations, state institutions and other major public improvements. These and other factors had to be weighed against the effect on agriculture in the rural areas and the local community needs in Stockton, a city of 90,000 people. The location within the city was tied in closely with the traffic phase of the local master plan.

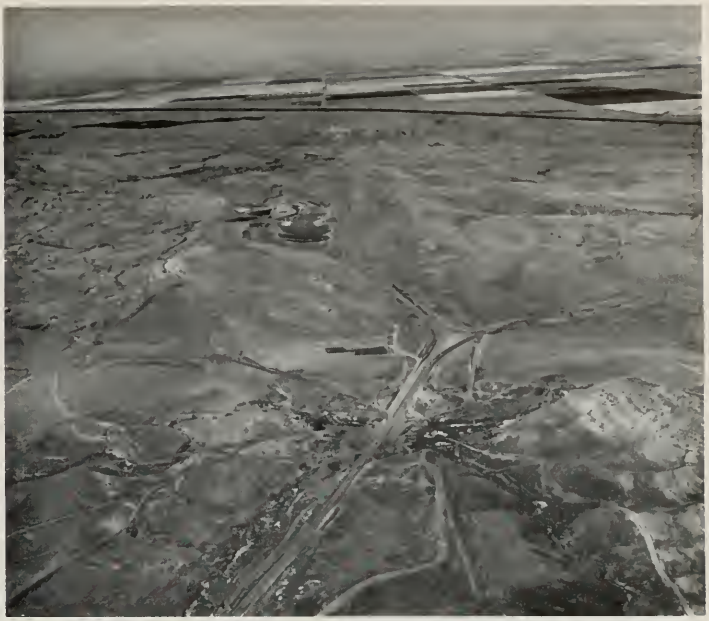
The overall length of the adopted route between US 99 near Wheeler Ridge to US 50 west of Tracy is 240.8 miles. It is 1.5 miles longer than the shortest practical route and 3 miles longer than the great circle distance. It can be constructed at less initial cost than the shortest practical route.

Design Mapping

Following adoption of all the route segments by the California Highway Commission for this 241-mile portion between US 99 near Wheeler Ridge and US 50 west of Tracy, the work of preparing plans and specifications for large scale (1 inch = 50 feet) photogrammetric design mapping was started. Seven mapping contracts, varying in length from 25 miles to 52 miles, were awarded and have been completed.

Design mapping specified covered a width of 1,300 to 1,400 feet, with two-foot contours and/or spot elevations. There were some interesting procedures developed for this design mapping which the following two examples illustrate.

First, it was possible, from the USGS maps used in the planning studies, to equate the projected freeway centerline for the 241 miles to



Adopted Westside Freeway routing. Looking east from above the junction of the Fresno-Coalinga Road and State Sign Route 33.



Adopted Westside Freeway routing. Looking north from Del Puerta Canyon Road. Delta-Mendota Canal at right.

the three zones of the California Co-ordinate System crossed. Some 170 miles of this 241 miles is over comparatively flat terrain where spot elevations were specified to adequately depict the ground surface for earthwork determination. In these areas it was therefore feasible to specify a cross section pattern of spot elevations to center on the previously co-ordinated and stationed centerline. As a consequence, earthwork terrain data for electronic computer input can and is being keypunched directly from prints of the resulting design maps.

Section Corner Data

Second, the methods developed to obtain data for the some 1,200 land section corners located along the 241 miles of the route which has been mapped.

To control the primary ground surveys for the mapping along centerline, basic horizontal control monuments were established by state forces at intervals of from two to five miles using electronic distance measuring equipment. The mapping contractors were required to set semipermanent monuments in the immediate vicinity of the proposed centerline at intervals of from 1,000 to 2,000 feet, and to fix their positions by second order traverses. As they would have personnel and equipment in the area to set and position these second order "mile monuments" it was advantageous to require the contractors to co-ordinate many existing specified monuments located along the mapped strip, both inside and outside the map limits.

These "existing specified monuments" were generally section corner monuments found by a two-man state crew or were temporary monuments set by these state forces in the vicinity of section corners which could not be found during the initial search. These provided a convenient co-ordinate tie point to aid in further search. To avoid confusion with true corners, these temporary monuments were destroyed after use in the return search for the corner by the division's engineers.

These two examples are illustrative of several that have been employed during the planning and mapping phases for this highway to minimize the amount of work and time required during actual design. The Westside Freeway project is particularly well suited to the development and application of improved methods similar to the above.

Four-lane Construction

Design work on the 241 miles which have already been mapped for design purposes between US 99 and US 50 is well under way. Initial construction will be four lanes with a minimum 84-foot median width. Some 16½ miles of independent alignments for the two roadbeds are used where they best fit the terrain. The minimum radius of curvature will be 5,000 feet.

Independent grade lines for the two roadbeds will be used throughout. In general, and with few exceptions, such as at railroad overheads, maximum ascending grade rate will be two (2) percent and descending will be three (3) percent.

Construction of this route will depend on the availability of Interstate financing. The acquisition of right-of-way will start after July 1, 1960, as basic design features to ascertain right-of-way needs are nearing completion on the 241 miles south of Tracy.

Development of the Westside Freeway is unique from the standpoint of the California Division of Highways, as it is the longest single project on entirely new alignment ever undertaken. The foregoing at least provides a bird's-eye view of the nature of this project and the progress that has been made on it to date.

COUNTY PLAN

Continued from page 20 . . .

ultimately be necessary for the preservation of a good local traffic pattern.

During the development of the SCR 26 study and the SCR 62 study, the existence of a master plan has greatly simplified the planning phases of these two far-reaching surveys. The mere fact that we had an overall plan for Orange County made the SCR 62 study much easier and assured the co-ordination of the study on a county-wide basis.

Similarly the arterial highway financing program has developed many advantages for Orange County. Not only have we improved intergovernmental relationships on the city-county level, but we believe that the program has definitely developed a more efficient expenditure of highway users taxes than by any other method that so far has been proposed. Our program is designed to serve the public as a whole and disregards arbitrary boundary lines, which the average motorist does not recognize.

Bridge Bids Called; Completion in 1963

The State Division of Highways has called for bids on construction of the San Pedro-Terminal Island Bridge over the main channel of Los Angeles Harbor.

Bids on the substructure contract were opened at 2 p.m. September 27 in Sacramento. The superstructure bids were opened at 10 a.m. September 28.

Total estimated cost of the entire San Pedro - Terminal Island Bridge Project, including financing, right-of-way and approach roadway costs, is $20,000,000 of which approximately $13,000,000 is budgeted for the bridge.

The project will be financed in part from $7,000,000 in Toll Bridge Authority revenue bonds. The bonds will be placed on the market next month.

The remaining money for the project will be provided from state highway funds and from state gas tax funds available to the City of Los Angeles and Los Angeles County.

The bridge will be Southern California's first state toll bridge. The suspension type structure with steel girder approach spans will be 6,010 feet long.

The bridge will have the third longest span in California, exceeded only by the Golden Gate and San Francisco-Oakland Bay Bridges. The main span will be 1,500 feet between towers.

The bridge towers will rise 370 feet above the water line. Vertical clearance for ships in the main channel will be 185 feet. The bridge deck will provide four traffic lanes.

Plans call for the start of approach roadway and toll plaza construction next summer. The entire project is due for completion in the summer of 1963.

The bridge will be located near the west end of Terminal Island.

Survey Controls

City, State Co-operate on Terminal Island Project

By ALLAN WHITLOCK, Assistant Highway Engineer



RECENTLY the District VII Survey Section of the State Division of Highways received valuable co-operation from the City of Los Angeles Engineering Department Surveys and Geodetic Sections in establishing initial survey controls for the San Pedro-Terminal Island Bridge construction. Preliminary engineering studies covering this bridge, for which Governor Edmund G. Brown, Assemblyman Vincent Thomas and others officially broke ground on May 28, 1960, were carried out by Supervising Bridge Engineer John W. Green, who recently retired from state service.

The bridge will span the Los Angeles Harbor main channel in the vicinity of Boschke Slough on 350-foot height suspension towers. The main span of the bridge has a water clearance of 190 feet so that the largest ships afloat can go under it. The sweeping suspension cable span with main towers 1,500 feet apart will become a major landmark for the Port of Los Angeles. The bridge will be an integral part of the freeway system linking San Pedro with Long Beach.

Accurate control of alignment for construction of the bridge, in this area of known subsidence and earth movement, requires careful engineering procedures. Because of close tolerances in the erection and assembly of components in a bridge structure of this type, precision of survey control must be of a degree which will preclude even minor accumulative errors.



Looking southwest at the site of the future San Pedro-Terminal Island Bridge showing locations of precise control survey stations.



Tellurometer slave station operator Bob Barron, Los Angeles City Engineering Department.



Barron reading Tellurometer data to recorder.

Project Is Co-operative

As a part of the joint co-operative effort by city and state forces, the City of Los Angeles Engineering Department has fielded a triangulation and Tellurometer team to establish mutually beneficial control monuments during the initial phases of this undertaking. The city's vital interest in this precise control net is very fortunate for the State. The City Surveys and Geodetic Section forces have extensive familiarity with the Los Angeles Harbor area and their current surveying practices have attained a high degree of accuracy as is most necessary in this area of frequent earth movements. Mr. Benjamin O. Badgley, Engineer of Surveys of the City of Los Angeles Survey Division, appointed Messrs. Henry Beitler, Senior Survey Supervisor; Alfred Boysen, Senior Geodetic Survey Supervisor; William Brackett, Geodetic Survey Supervisor; and Ben Pratt, San Pedro Office Survey Supervisor, to supervise the setting of four triangulation and traverse stations in this area. These points were established at strategic positions on the mainland and on the island from which distance observations have been made with the Tellurometer during daytime, and angular measurements have been obtained at night with a T-3 theodolite.

Four Stations Set Up

Control stations were placed at the intersection of Keel Street and Swinford Street, on Dock Street west of Altoona Place, on Dock Street at the westerly projection of Bayonne Place and on the southwest parapet porch of the American President Lines clock tower at rhe foot of Neptune Avenue. These points were tied into the existing city survey network for more extensive first order control on the island and on the mainland. This control network expansion by the city will enable the State to determine, by periodic observations, the amount of movement of the abutment piers as well as assist in the actual layout and fabrication of the bridge structure. The city intends to use these same stations for future checking of subsidence and earth movements.

It is common practice in geodetic surveying to name the stations in a net-



Bob Barron of Los Angeles City Engineering Department operating Tellurometer. Al Whitlock of State Division of Highways recording at Station "Keel."

work with some appropriate and locative title or nickname. In the case of the Island bridge control point, Station "Keel" seemed nautical enough and was located on Keel Street. Station "Hank" was named for the two Henrys who were instrumental in geting this work done, Hank Compagnon of the Division of Highways and Hank Beitler, City Engineer's Department. "Greensfolly" was the name jokingly tacked on to the major station on the Island, honoring John W. Green and his sense of humor, and Station "Hi Boy" is up on the parapet porch of the clock tower, American President Lines, 150 ± above the water.

Appreciation Expressed

In carrying out this survey control procedure, the State Division of Highways was represented by Assistant District Engineer A. D. Mayfield, District Chief of Surveys A. K. Goldin, Bridge Department Construction Engineer George Laird, Senior Bridge Engineer John Curran, Survey Supervisor Henry Compagnon, Survey Party Chief Eldon Thompson and the author. It is their considered opinion that the true meaning of the word cooperation has been demonstrated by the manner in which Los Angeles City and State of California forces worked together on this project with everyone striving for best possible results with least possible cost. It is their sincere belief that a few words of appreciation and thanks are due the engineers and officials of the City of Los Angeles for their invaluable contributions in solving this complex problem of survey control.

BUREAU ASSIGNED RESPONSIBILITY FOR NEW FEDERAL DRIVER REGISTER

Secretary of Commerce Frederick H. Mueller has designated the Bureau of Public Roads, under the direction of Federal Highway Administrator Bertram D. Tallamy, to establish and maintain the Driver Register authorized by Congress and approved by President Eisenhower on July 14. The register will serve as a clearing house to identify for the states those motor-vehicle drivers whose licenses have been revoked because of driving while intoxicated or conviction of a traffic violation resulting in loss of life.

Mueller emphasized that the federal government is not entering either the driver-licensing or traffic-law-enforcement fields. By terms of the enabling legislation, the register will be operated as a voluntary state-federal enterprise. Those states that participate will furnish the Bureau of Public Roads with identifying information on drivers whose licenses are being revoked for the specified causes, and may request the bureau to check new license applicants against the register for a record of previous revocation.

'Tempus Fugit' Corner

Twenty-five years ago. The following items appeared in the September 1935 issue of *California Highways and Public Works.*

WORLD'S LARGEST BORE

A novel safety method of excavating Yerba Buena Island tunnel, the world's largest bore tunnel, was conceived by Chief Engineer Purcell of the San Francisco-Oakland Bay Bridge and his staff, the novelty of which consists chiefly in that they first build the tunnel and then dig it out.

Three bores were drilled through the island for the tunnel. The three bores, two at either lower side and one in the crown, are blocked out into a horseshoe-shaped excavation through the rocky island. This horseshoe-shaped excavation is then concrete and steel lined from three to five feet thick before the inside or core of the tunnel is dug out.

With the tunnel completely lined for more than 350 of its 540-foot length, a power shovel enters the portal to remove the thousands of cubic yards of rock within this 58 by 76-foot bore. Through this bore a four-story building could be pulled upright.

CONSTRUCTION BUDGET

The revised state highway budget for the 87th-88th fiscal years, July 1, 1935 to June 30, 1937, provided $21,545,370 for major project construction throughout the State during the biennium.

MUD FLOW

Fed from a glacier on the north slope of Mt. Shasta, Whitney Creek (also known as Midnight, or Inconstant), 10 miles northeast of Weed on US 97, flows only when the weather is warm enough to cause the melting of the glacier. During this period the flow generally reaches the highway about 5 p.m. and stops about 2 a.m., depending on the temperature.

On August 28, a warm thunder storm on the glacier caused the snow and ice to melt and the resulting flow soon assumed the proportions of an avalanche. A torrent carrying mud, rocks, and trees damaged Whitney Creek bridge, washed out 1,000 feet of S. P. track, and covered US 97 with four feet of rocks and mud.

Equipment was rushed to the scene the same night and the road again opened to traffic on August 30. G. H. Nutting was the maintenance superintendent.

THOMAS CALDECOTT HONORED IN TUNNEL RENAMING



The twin-bore Broadway Low Level Tunnel has been officially renomed Caldecott Tunnel in honor of the late Thomas E. Caldecott of Berkeley, who, as chairman of the Alameda County Board of Supervisors and President of the Alameda-Contra Costa County Joint Highway District 13 was instrumental in pushing through the ¾ mile long bore which is the longest highway tunnel in the state and one of its most heavily travelled four-lane sections. Participating in the unveiling of the sign on August 18th are, from left, rear row—J. P. Sinclair, Assistant State Highway Engineer; Assemblyman Don Mulford; Supervisor Kent Pursel of Berkeley; and Superior Judge Thomas E. Caldecott and Attorney Chester E. Caldecott; sons of the late supervisor. Front row—from left—Mrs. Chester Caldecott, Sally, 12; Mrs. Thomas E. Caldecott, widow of the supervisor; and Tommy, 9. Sally and Tommy are children of Chester Caldecott and grandchildren of the man honored by the renaming. The tunnel, completed in 1937, at a cost of $3,600,000 carries from 40,000 to 50,000 cars a day and soon is to be supplemented by a third bore for which $12,500,000 has been budgeted by the California Highway Commission. The renaming ceremony was under the auspices of the Oakland Chamber of Commerce, William A. Sparling, General Manager. A description of the new tunnel project appeared in the July-August issue of California Highways and Public Works.

Folsom Park

State Agencies Co-operate in Improvement of Beach Area

By E. L. MILLER, Assistant District Engineer—Operations



One example of the frequent co-operative enterprises between state agencies was the completion earlier this year of $300,000 in construction and improvements at Folsom Lake State Park by District III-Marysville for the Division of Beaches and Parks.

Four additional recreational units were either built or improved at this popular family play area situated roughly 25 miles northwest of Sacramento, or about five miles north of US 50 through the City of Folsom.

Two of the projects were let to contract, and two were undertaken by the district as day labor jobs.

Fed by the American River on its way from the high Sierras in Placer and El Dorado Counties to its confluence with the Sacramento just north of the City of Sacramento, Folsom is one of the many man-made lakes that have made possible the spectacular boom in water sports in recent years.

Previous improvements had made the area increasingly favored by boating and water skiing enthusiasts as well as swimmers and picnickers. The 19,000-acre water playground became a focal point for the summer recreation of Northern California families.

More Funds Allocated

As a result of the growing inadequacy of the existing facilities, Beaches and Parks allocated funds for more



Looking south at Granite Bay facilities during near high water mark in June. This year's improvement of the swimming area (lower center) extended usable beach by placement of local decomposed granite below the visible beach in the photo to an area roughly bounded by the outer ring of buoys making the former rugged, rocky surface safer and more usable during low water. Entrance and connector roads, some ramps and initial beach were constructed for the Division of Beaches and Parks in 1958 under a Division of Highways contract.



Beals Point with Folsom Dam in the background. The State prison is barely visible upper right. The beach in the foreground, shown at high water, was extended to accommodate swimmers during lower lake level later in the season. The former island (extreme left) originally separated from the shore, was connected with fill. Several persons had drowned in the past while trying to swim the gap. Future plans call for paved parking space in the center and boat launching ramps on the cove at the far side of the point.

boat launching ramps, improved beaches, parking space, and public conveniences, and asked Highways to develop plans, administer the contracts, and supervise construction.

The agreement was executed.

Completion of the newest units has caused an even more than usual yearly increase in park visitors. In fact, Folsom ranked first in popularity over all the 150-plus units in the state park system during this year's Fourth of July holidays with a total attendance of 35,000.

The number of persons using all Folsom's recreational areas this year is well over that of last, and, if the trend continues, the season should wind up with a record-smashing 3,000,000 using the park's public facilities. Last year's total was slightly over 2,000,000.

These figures and estimates, supplied by former Park Supervisor Richard L. Brock, include the entire park area—both the developed and undeveloped regions.

Largest Project

Largest of the four newest projects was the $135,000 installation at the Lake Natoma unit located approximately two miles downstream from the dam and main lake. The job included four boat ramps, access roads, parking lots for cars and trailers, and a kiosk-type office building. Previously the area was undeveloped and covered with cobbles from former gold dredging operations. Brighton Sand & Gravel Company of Sacramento was the contractor. Harold J. Levernier was the resident engineer.

The Mormon Island unit on the main lake shore received a ramp, roadways, parking, and an office building at a cost of $92,000. Claude C. Wood of Lodi was the contractor, and Levernier the resident.

At the other two locations on the main lake, the terrain was graded and shaped to extend existing beaches and swimming areas. The work at Beals Point included approximately 30 acres, and at Granite Bay about 12. Both were handled by the district using hired labor and rented equipment. Potentially hazardous conditions were eliminated by smoothing irregularities on the beach and lake floor. A sand blanket was applied where required at several locations. Frank Gau was resident engineer for both projects.

Robert E. Biggs was construction engineer for all four jobs.

Work was undertaken beginning in the fall of 1959 to take advantage of the natural low level of the lake and achieve maximum effectiveness of the improvements.

An unusual sidelight on the construction of the ramps at the Lake Natoma unit was the dovetailing, through the co-operation of the U.S. Army Corps of Engineers, of the release of water from two major dams 150 air miles apart: Folsom, and Shasta Dam north of Redding, the controlling agent of the Sacramento River.

Minimum Discharge

A minimum amount of water is released daily from Folsom which results in a normal, constant variation of about six feet in Natoma, the storage reservoir behind Nimbus Dam five miles farther downstream just north of US 50. However, this was not enough to permit ramp construction to a level sufficiently low to accommodate boat launching trailers.

In order to lower Natoma, water had to be released from Nimbus and withheld at Folsom, resulting in a less than minimum discharge into the American River below Nimbus.

Beforehand, this action had to be co-ordinated by the Corps of Engineers at both Folsom and Shasta so that additional release at Shasta would tend to make up for the deficiency in the Sacramento below their confluence. At that point the American ends and the Sacramento continues south and west into the rich delta agricultural region, joins the San Joaquin and together empty into San Francisco Bay by way of the Carquinez Straights and San Pablo Bay.

Besides administering the recreational units at Folsom, the park headquarters office under the direction of Park Supervisor Glenn A. Jackson is also charged with enforcement of water safety regulations.

Richard H. Wilson

Richard H. Wilson, retired Assistant State Highway Engineer of the Division of Highways, died on August 14 following a short illness.

An engineer of wide experience, Wilson was in charge of the administrative functions of the division at the time of his retirement in 1957 which included those of city and city co-operative projects, county and county co-operative projects, service and supply and office engineer.

Born in Leitchfield, Kentucky, he attended George Washington University and received his degree in civil engineering from the University of Michigan in 1912. Wilson came to work for the California Division of Highways in 1912 as a resident engineer in Willits. From 1915 to 1927 he was with the Washington State Highway Department, first as resident and later as district engineer. During World War I he served with the 20th Engineers, rising from private to first lieutenant.

Wilson returned to the California Division of Highways in 1927 as Maintenance Engineer in District 1 (Eureka). After serving as Office Engineer and Principal Highway Engineer in the Sacramento Headquarters Office, he was appointed Assistant State Highway Engineer—Administration, in 1947.

Wilson was a committeeman of the American Association of State Highway Officials. He was also a member of the Western Association of State Highway Officials, the American Society of Civil Engineers and the American Concrete Institute. He was a member of the Chanters, Ben Ali Temple, American Legion Post No. 61 and Phi Kappa Sigma fraternity.

Wilson is survived by his wife, Agnes, a daughter, Betty Jo, of Sacramento, a son, Jack, of Los Angeles, and a granddaughter.

August tabulations of the Right of Way Department of the Division of Highways showed that during the month of July 590 parcels of land were acquired at a cost of $6,597,893.

CALIFORNIA WINS 10th I.T.E. AWARD IN 12 YEARS



Presentation of a national award to California for excellence in traffic engineering during 1959 was made in the office of Governor Edmund G. Brown on September 2. Participants are, left to right, State Highway Engineer J. C. Womack; Governor Brown; Ross T. Shoaf of San Francisco, past president of the Western Section, Institute of Traffic Engineers; Traffic Engineer George M. Webb of the Division of Highways; and State Director of Public Works Robert B. Bradford.

For the 10th time since 1948, California has received an award from the Institute of Traffic Engineers for excellence in its traffic engineering program.

The latest certificate, presented to Governor Edmund G. Brown on September 2, 1960, by Past President Ross T. Shoaf of the I.T.E.'s Western Section, was one of two such national awards for achievement during 1959. Michigan was the other recipient among the large states.

The award was voted by a committee of judges representing the I.T.E. on the basis of reports submitted by the various states in the annual inventory of traffic safety activities conducted by the National Safety Council.

"The continued high level maintained by your Division of Highways in the performance of the traffic engineering function must be a great satisfaction to you," Edward G. Wetzel, president of the institute, wrote the Governor. "We compliment the State of California for its efforts in this area so important to the safety and convenience of the motorists using California's highways."

U.C.L.A. Will Host Job Study Group

Universally applicable problems in engineering and management will be considered by a universal audience of engineers and managers for 10 days beginning January 23d on the UCLA campus.

University of California Extension has issued invitations to representatives of every major country in the world and the 1961 conference will mark the seventh year that the course has been given.

According to the co-ordinator, Reno Cole of the University Engineering Department, participants will have a choice of 23 subjects being taught by 30 professors, industry specialists and managerial consultants.

Dogwood Road

Modern 16-mile Highway Replaces Graveled Road in Imperial County

By D. E. PIERSON, Road Commissioner, Imperial County

The recently completed project on Dogwood Road concludes the improvement of this 16.5-mile Imperial County highway between the community of Heber, located six miles southeast of El Centro on US 99, and the City of Brawley.

This County Federal-Aid Secondary Route, 1262, was constructed over a two-year period as two separate FAS contracts. The first of these, completed in June 1959 at a total cost of $411,720, includes the southern 3.5 miles and the northern 4.0 miles of the route. The central 9.0 miles cost approximately $442,800 and was completed in June of this year.



Looking southwest toward the City of El Centro with Dogwood Canal in the foreground paralleling Dogwood Road.

Dogwood Road is a north-south facility traversing the heart of Imperial County's irrigated valley. The area served is devoted to extensive agricultural crops including sugar beets, lettuce, carrots, tomatoes, melons and alfalfa. Since Dogwood Road provides access from adjacent farms to the two largest Imperial County Cities, El Centro and Brawley, the construction of this route truly qualified as a "farm to market" FAS improvement.

Had Gravel Surfacing

Prior to construction this route existed as a partially graveled road, 22 to 28 feet wide, on generally tangent alignment and level grades, and at an elevation approximately equal to adjacent fields. The improvement made along the existing traveled way consists of road-mixed surfacing over imported base and subbase for a total structural section thickness of 21 inches, and a width of 24 feet for the northern 8.5 miles and 26 feet for the southern 8.0 miles. Graded roadbed width is 32 and 34 feet respectively.

An irrigation canal exists adjacent to Dogwood Road over a large portion of the route and the resulting seepage from the canal presents a problem in providing a stable roadbed. This problem has been minimized consistent with economy by designing the grade of Dogwood Road 2 to 2½ feet above adjacent fields. The need for raising the grade as high above existing ground as practical necessitated importing nearly all the roadbed materials. High quality aggregates are not available in the irrigated portion of Imperial County so it was necessary to haul materials from the desert areas 20 to 30 miles to the project.

It is the practice in this county to advertise FAS projects during the fall so that most of the work can be accomplished during the winter months, the period of most favorable weather in the Imperial Valley. A great deal of competitive bidding has resulted from fall advertisements the past several years as northern California contractors are often interested in winter jobs.

Goes Through El Centro

One and one-half miles of the nine-mile project just completed passes through the easterly edge of the City of El Centro. The city agreed to help finance the portion of the project located within the city limits, and $50,000 was provided from ⅛-cent gas tax funds for this purpose.

The completion of this FAS route was therefore the result of co-operative effort by city, county, state and federal officials. Surveys and plans were made by the county over the 16.5-mile route with joint city effort for the 1.5 miles within El Centro. Materials investigations and tests, and construction engineering were accomplished by state personnel at county expense. US Bureau of Public Roads officials acted in an advisory capacity and assisted in processing of the projects.

The approximate cost of the improvement of this FAS route is summarized below:

Imperial County gas tax funds	$84,881
City of El Centro gas tax funds	50,000
State matching funds	276,816
Federal-aid secondary funds	442,823
Total	$854,520

The completion of this 16.5-mile county highway through one of the nation's richest agricultural areas serves as an illustration of the accomplishments of the FAS program in Imperial County, a program which includes co-operation among all levels of government as one of its inherent features.

At the end of July, 306 state highway contracts totaling $460,678,000 were under way, an all-time high.



Dogwood Road Reconstruction (see previous page). An aerial looking south along Dagwood Road from above Browley. Plaza Park is in the foreground. The Southern Pacific Railroad trocks cross Dogwood Road diagonolly in the bockground.

Mobile Lab

New Truck Unit Facilitates On-the-spot Field Tests

By F. H. KREFT, Highway Engineering Associate, District XI

"One test is worth a thousand expert guesses" . . . This quotation is generally attributed to Dr. August von Wassermann but how well it describes the valuable role of testing in the construction of our highways.

One of the most important phases of this role is in the field of quality control. Those persons associated with the inspection of materials being produced for today's highways know that this field has had increased demands. To quote C. E. Walcott, District XI Construction Engineer, "The high rate of production of the present-day contractor places a moral responsibility upon the engineer to review the contractor's plant and procedures in advance and to organize his inspection so that the question of costly corrective action due to nonspecification material does not arise."

The problems of quality control are most difficult in those instances where the material is close to borderline on a particular specification. In these cases, repeated and accurate testing is the only method of determining whether a material meets specifications or does not.

Control Difficulties

The difficulties of quality control are further complicated by the type of operation required in freeway construction. Often the production runs are short in duration because of the limited amount of roadway that can be constructed at any one stage of operation. This means that testing facilities placed at any plant on a semi-permanent basis get very little use and a considerable amount of moving of testing equipment is required.

With the above impressions in mind, District XI has acquired a mobile laboratory to perform its needed tests. It has not been an easy task because the equipment department does not handle a vehicle as such. It was finally decided to use a two-ton truck with a line utility body for the basic needs. This is the type of truck that normally accompanies a district drilling rig and has numerous compartments and sections for storage. Most of these compartments have been used to hold the testing equipment that has been placed in the truck.

This equipment includes an air compressor, portable electric generator, sand shaker, sand equivalent shaker, butane range and tanks, moisture teller, field extractor, 25-gallon water tank, and a stainless steel sink. A counter has been built into the interior of the truck and with the existing facilities, it provides two work counters—24 inches deep and 10 feet long. By providing the apparatus and tools necessary, this amount of work area will allow two men to perform field testing when need be.

Radio Communication

A radio has been ordered for the vehicle to provide communication between the plant inspector and the resident engineer.

According to the Headquarters Equipment Department who assembled the unit, the truck literally takes the laboratory to the field, replacing the necessity of bringing in field samples to the laboratory. Special consideration was given to clearances, weight



View of interior of mobile laboratory and with generator compartment door on left side of vehicle down.

distribution, and the terrain over which the unit will operate. Spaces were provided to accommodate specialized equipment necessary to operate the unit and still be within a proper weight distribution. A unit such as this special laboratory truck must have every available cubic foot properly utilized so that it may have all the necessary items on hand to do its job.

One piece of testing equipment has required special placing — the sand equivalent shaker. It was discovered that any amount of movement inside the body of the truck effected the Sand Equivalent Test results. Therefore, it was decided to place the shaker in an outside compartment. A small shelf was built on the door of the compartment for the stabbing and washing portion of the test and the bottle of working S.E. solution is hung three feet above the shelf. Upon completion of the washing of the test sample, the S.E. cylinders are placed on an express truck bed or a small table for the 20 minute undisturbed settlement portion of the test. By placing the cylinders away from the Mobile Lab, other work can be accomplished within the lab during this 20-minute interval.



View of right side of mobile laboratory with compartments open, showing air compressor, butane tanks, sand equivalent test area and equipment, and storage for hoses and electrical cords.



View of interior of mobile laboratory showing work area and plant inspector performing calculations.

Tests Performed Rapidly

All the field control tests described in the Construction Manual can be accomplished in this vehicle as well as the determination of cement content in cement treated aggregate by the method of titration (Calif. 338A) and the determination of asphalt and moisture content of bituminous mixtures (Calif. 310-A). Furthermore, the tests are performed quickly and dependably at any location. At present, our Mobile Laboratory is working in Painted Gorge in Imperial Valley at a R.M.S. aggregate plant, many miles from power and water. It has been moved over 100 miles overnight with no particular hardship and been ready for performance the next day.

Talking About Highways — *Comments from Here and There*

The following quotes and comments about highways appeared recently in various California newspapers or were taken from other sources:

"B. W. Booker, Engineer"

"B. W. (Barney) Booker, who died of a heart ailment this week (July 18, 1960), was the highway engineer in charge of construction of most of the Bay area's existing freeway system.

"During the seven years prior to his retirement last year, Mr. Booker was Assistant State Highway Engineer for the nine Bay area counties. In all, he worked 38 years with the Division of Highways.

"Along with talent for handling the precise factual problems of engineering, his job called for the exercise of considerable political skill in dealing with touchy route location matters.

"On occasion, Mr. Booker put his own opinions bluntly. But he respected the right of others to voice their opinions, even when they were plainly wrong. He and his staff specialized in giving everyone a fair hearing.

"Mr. Booker was one of those few professional men who are called upon to adapt the democratic process to new sorts of public projects—and whose success bears heavily upon our continued freedom. We hope never to see the last of his breed."—Palo Alto *Times*.

* * *

"Mass Transportation"

"Our freeways (in Los Angeles) actually constitute a modern, mass transportation system, since they provide for the movement of literally millions of people every 24 hours. The Pasadena and San Bernardino Freeway carry about 120,000 vehicles a day, the Santa Ana 140,000, the Hollywood and Harbor Freeways over 200,000 and 350,000 vehicles use the four-level interchange daily. Even with only one or two persons per vehicle, the four-level interchange (in downtown Los Angeles) accommodates over half-a-million Los Angeles area travelers each day of the year."—Address by *J. H. McDonald, Manager, Engineering Department, Automobile Club of Southern California.*

* * *

Co-operative Planning

An editorial in the *Stockton Record* pointed out that the first annual report of the State Planning Office praised as "a very significant accomplishment" the close co-ordination of the city with the district office of the Division of Highways in planning streets and highways.

The annual report noted that a state recommended route for the Westside Freeway coincided with the alignment recommended in the Stockton General Plan. Much of this route has now been adopted by the California Highway Commission.

"Stockton has reason to point with pride," the editorial concluded, "at this official recognition of its long-range blueprint for development encompassing the entire metropolitan area. Between the lines can be read the earnest co-operative effort of city planners and state highway engineers to achieve agreement on freeway alignment."

* * *

"Excellent Highway Plans"

The *National City Star News* reported that plans for the US 101 Beltline route in the San Diego area were presented to the four local governments concerned.

"The need for the road has been so well sold and apparently so well planned," the *Star-News* commented, "there was a minimum of difficulty in obtaining preliminary approval by all four agencies.

"Also, there has been sufficient prepublicity so that the citizenry had plenty of opportunity to fully understand some of the major problems which are faced when selecting a location for a 201-foot-wide, six-lane highway. This is indeed no small task in a region which is growing and developing as fast as San Diego County. And, it is especially true in a state where highways are built on a pay-as-you-go plan and running from five to ten years behind need.

"The lack of confusion is also evidence that the public has been well informed and is testimony to the fact that when nothing is withheld, the public as a whole is always most understanding. It is also a star in the crown of district engineer Jake Dekema of the California Division of Highways."

* * *

Bayshore Freeway

Work is now in progress on a project which will complete freeway development on the Bayshore Freeway (US 101 Bypass) between San Francisco and San Jose. The opening of bids on this job inspired these editorial observations in the *San Mateo Times*:

" 'Arterial' is perhaps the best word to apply to the (Bayshore) Freeway because it is, in very truth, an artery along which flows the lifeblood of commerce and transport for all the cities of the Peninsula . . .

"Without it the Peninsula, including San Francisco, would suffer from a sort of anemia. With it, a state of good health has been preserved.

"It has become somewhat fashionable in some quarters to decry freeways . . . and to overlook their obvious benefits. This is a completely unrealistic attitude, but not an unnatural one on the part of those who have in some way been inconvenienced by the progress which freeways represent. Fortunately, these persons have not been able to appreciably delay the ultimate construction of freeways where they are needed by the bulk of the population.

"There are more freeways to be built on the Peninsula, but it is likely that the Bayshore will remain 'The Freeway' in the minds of most of the present generations. Like the roads that brought greatness to Rome, the Bayshore Freeway has already played a significant role in the advancement of the Peninsula."

Value, Not Price, Is Question

In an editorial entitled "High, Yes, But Worth It," the Tulare *Advance-Register* takes this view of the current advertising campaign calling attention to gasoline taxes:

"Being as how we pay out good money for the newspaper in which the question appeared, we would guess that we're entitled to put in our two cents worth of answer. And so the answer is: 'No, indeed!'

"The question? It appeared in something of an outsize ad inserted in a Los Angeles newspaper yesterday morning, and it read this way: 'Today, many people throughout this State think that gasoline taxes are too high. What do you think?'

"Sure, we all think that 10 cents a gallon is a pretty stiff price to pay. But are we getting our money's worth? That—and not just a simple 'Do you think that gasoline taxes are too high?'—is the real question.

"To that question, our answer—and we'd guess yours too—just has to be 'Yes, indeed.' If you're in doubt, just take a drive through California (a pretty big assignment in itself). Take a look at the fine highways, the fine secondary roads and even the fine major city streets that these gas tax moneys have financed for your convenience and driving pleasure.

"We Californians are a car-happy lot. Our State is so constructed that we just couldn't get very far in it (even if we wanted to) without one or more cars per family.

"And the very fact that all of these cars are rolling over our highways and byways every day means just one thing: Our highway building and maintenance program must go on and on and on to meet the demands made by California's motorists.

"So, what better way to finance this highway construction and upkeep than through the gasoline tax? After all, the people who pay the gasoline tax—and in sums commensurate with the amount of use they give their cars—are the ones who have brought this need for always bigger and better highways in California."

Schoellkopf Named Assistant Comptroller

Appointment of Andrew B. Schoellkopf as Assistant Comptroller of the State Department of Public Works has been announced by Robert B. Bradford, director of the department.


A. SCHOELLKOPF

Schoellkopf has been on the accounting staff of the Division of of Highways for most of his 23 years of service with the State. His latest promotion, effective August 1, 1960, fills the vacancy created by the retirement of Bert Sellier, who had been Assistant Comptroller since 1945.

In his new post, Schoellkopf's responsibilities will include Division of Highways disbursement procedures, internal audit, administration of the headquarters accounting office, and various other functions of the Department of Public Works as well as the Division of Highways under the direction of Comptroller E. Roy Higgins.

Schoellkopf is widely known in state circles as the recipient of the largest merit award for an employee suggestion ever accorded in California. In 1959 he was presented with a check for $11,808 as a result of his proposal, resulting in enabling legislation, that state funds placed in deposit by courts in condemnation cases be made available for investment by the State Treasurer. The first year his suggestion was in effect saw a gain in interest earnings to the State of more than $140,000.

He was born in San Bruno in March 1915 but has lived most of his life in Sacramento, and holds an associate in arts degree from Sacramento City College. He is a licensed public accountant.

Schoellkopf came to work for the Division of Highways as a file clerk in September 1937. In 1942 he moved to the accounting department as an intermediate clerk and moved up through the promotional ranks. He was appointed an accounting officer III in March 1957.

He is a veteran of European service with the 84th Infantry Division in World War II.

Schoellkopf and his wife, Bernice, live at 5316 Sandburg Drive, Sacramento. They have two children.

He has been active in various civic organizations, and is a past president of the River Park Improvement Association. He is a director of the California State Employees Credit Union No. 1.

F. H. 'Fair' Young Retires in L. A.

F. H. "Fair" Young, Chief Accounting Officer for District VII in Los Angeles, retired on August 1. He had been with the Division of Highways since 1936 when he came to work as a timekeeper clerk on a construction project on the Ridge Route.


F. H. YOUNG

Young was responsible for many innovations in the district's accounting setup including the present system for handling the large rental collections from state highway property in the Los Angeles area.

Young was born in Salt Lake City, Utah, and attended schools there and in Portland, Oregon, moving to California in 1930.

After coming to work for the division, Young was assigned to the District Maintenance Department in 1938 where he handled the co-ordination of the office and budget work of the maintenance field offices. He was appointed district chief clerk in 1948.

A World War I veteran, Young served with the 148th Field Artillery in France and Germany.

Young and his wife, Ethelyn, plan to do some traveling following his retirement.

As certified in July to the State Controller, total mileage of county-maintained roads increased during the 1959-60 fiscal year from 69,078 to 69,442.

AVENUE OF GIANTS PARKWAY OPENED ON HIGHWAY 101



The Avenue of the Giants, a parkway through the redwoods of Humboldt County designated by the 1960 Legislature, was dedicated August 27 with ceremonies held at High Rock.

Governor Edmund G. Brown was the principal speaker. Participating was a large contingent of state and local officials and civic leaders

The Avenue of the Giants is a section of present and former US Highway 101 extending from about Miranda on the south to the Englewood interchange of the new freeway on the north. It is nearly 25 miles in length.

When freeway work is completed the Avenue of the Giants will be maintained as a parkway by the State Division of Beaches and Parks. Heavy, fast traffic will use the freeway, permitting leisurely driving through the scenic area for appreciation of the natural magnificence of the redwoods.

(Eureka Newspapers photo)

Newest Highway Research Board Committee Will Acquaint Public With Latest Findings

A new committee to better acquaint the public with important findings in highway research has been established by the Highway Research Board, National Academy of Sciences-National Research Council, Washington, D.C.

Pyke Johnson, chairman of the board, has announced that John W. Gibbons, Director of Public Relations for the Automotive Safety Foundation, will serve as chairman of the newly formed Committee on Public Dissemination of Research Findings. Major duty of the committee will be to provide public information media with major results of the research reports presented to the board.

The Highway Research Board will issue nearly 100 publications this year, containing reports on several hundred research projects.

In announcing the new committee, Mr. Johnson said:

"A great many dedicated men in highway research are advancing the frontiers of knowledge in this field. In economics of highway transportation, in development of new equipment and materials for highway construction, in design of urban expressways with high capacity, in safety, in traffic control, and many, many other areas, they are producing more and more of the information this country needs in order to build better, safer highways.

"The desire of the press, we know, is to take such findings another step—that is, to interpret their significance to the particular readership they represent. We hope that the new committee can be helpful to them."

R/W Deputy Chief E. F. Wagner Retires

Elton F. Wagner, Deputy Chief Right-of-Way Agent for the Division of Highways in Los Angeles, retired on October 1 after 31 years of service with the State.

Wagner began his state career with the design section of the division's Los Angeles office in 1929. He was appointed Deputy Chief of the Right-of-Way Department for the whole division in 1949.



E. F. WAGNER

Wagner has achieved national recognition for his work in the fields of right-of-way education and training. He served on the Educational Committee of the American Right-of-Way Association and was chairman of the Standing Committee on Education for the Right-of-Way Department of the Division of Highways. Known as one of the outstanding right-of-way technicians in the nation, he has distinguished himself by his contributions to the development of policies and procedures relative to advance purchases of highway rights-of-way.

Wagner was born in Great Falls, Montana, attended schools in Butte and later studied at the Montana State School for Mines. He spent the first seven years of his professional career in civil engineering work for hydro-electric projects in Montana and the next 2½ years on railroad location and construction in Colombia, South America, after which he joined the California Division of Highways.

Wagner is a charter member of the American Right-of-Way Association Chapter 1 of which he is now president.

John Webb Retires, Ritz Is Appointed

John C. Webb, District Right-of-way Agent for the California Division of Highways in San Diego, retired on August 31 after 20 years with the State.



JOHN C. WEBB

John H. Ritz, Senior Right-of-way Agent in the San Diego district, has been named to succeed Webb.

Born in Duluth, Minnesota, Webb attended schools in St. Paul and then worked for various engineers as a rodman and chainman. He began his right-of-way activity with the Road Department of the County of Los Angeles in 1927. In 1940 he was appointed an assistant right-of-way agent with the Division of Highways in Fresno.



JOHN H. RITZ

From 1945 to the present time, Webb has been a district right-of-way agent in San Diego. He has been responsible for right-of-way acquisition in San Diego, Imperial, and portions of Riverside Counties, involving over 5,000 real estate transactions valued in excess of $50,000,000.

Webb is a long-time member of the American Right-of-Way Association, being a charter member of Chapter No. 1, Los Angeles. He was co-founder of the San Diego club affiliate, and helped to form San Diego Chapter No. 11 in 1955, becoming its first president. He later served as a national director in 1958 and 1959.

Webb is married and has two daughters. He plans to work as a real estate consultant in El Cajon, following his retirement.

Ritz, who succeeds Webb, is a native of Atlantic City, New Jersey, and a graduate of George Washington University in Washington, D.C.

He worked for the Federal Bureau of Investigation in Washington, D.C., from 1935 to 1940 and was an investigator for an aircraft company and for the Los Angeles District Attorney's Office between 1940 and 1947. He served as the Deputy Mayor of the City of Santa Monica from 1945 to 1946. During World War II he served with the U.S. Air Force.

Ritz is married and has a daughter.

IN MEMORIAM

District III

Leland L. Myers, Highway Landscaping Supv. I.

District IV

William Minear, Laborer.

District V

Margaret L. Hansen, Senior Stenographer-Clerk.

District VI

Martha J. Varnum, Highway Engineering Technician.

District VII

Eugene E. Blohm, Highway Equipment Oper.-Lab.; William L. Bolstad, Senior Right of Way Agent; Leopold V. Chacanaca, Highway Equipment Oper.-Lab.; Yoshito T. Inouye, Engineering Student Trainee; E. Joyce LeBell, Delineator.

District X

Charles M. Howitt, Engineering Aid I; Martin G. McIntosh, Accounting Technician III.

District XI

Audley W. McCoy, Laborer.

Shop 10

Gordon F. Geil, Fusion Welder.

The new roadway on the lower deck of the Bay Bridge has been completed and is now in use from San Francisco to Yerba Buena Island. All freeway and street connections to the lower deck have been constructed.

During the month of July, the Department of Public Works apportioned $8,163,145 to the 366 incorporated cities in California.

William Bolstad

William L. Bolstad, Senior Right-of-way Agent with the Division of Highways in Los Angeles, died on August 15 as the result of an accident.

Bolstad came to work for the division as a draftsman in the San Bernardino office in 1925. In 1927 he became Division Right-of-way Engineer for the Missouri Highway Department. In 1937 he accepted a similar post with the Kentucky department.

He rejoined the California Division of Highways Right-of-way Department in 1948 and was promoted to Senior Right-of-way Agent in 1951. Bolstad supervised right-of-way acquisition for many important freeway projects in the Los Angeles area.

A native of Deerfield, Wisconsin, Bolstad attended schools in Detroit Lakes, Minnesota. He also studied at Luther College in Decorah, Iowa, and the University of Southern California.

Bolstad was a member of the American Right-of-way Association and a Mason.

He is survived by his wife and a son, William, now employed by the division in Los Angeles.

Leo S. Fahy

Leo S. Fahy, Disbursing Officer for the State Division of Highways, died on August 15 after a short illness.

A veteran state employee with 38 years service, Fahy was in charge of payments to highway contractors which totaled $300,000,000 a year.

Fahy started his career with the State as a junior clerk with the Division of Highways in 1922. He became chief clerk of the Bridge Department in 1925 and was moved up to the disbursing officer post in 1943.

Born in Roselle Park, New York, Fahy attended schools in Newark, New Jersey. He later studied at Walton School of Commerce in Chicago and Sacramento Evening College.

Fahy served with the 56th Engineers' medical detachment during World War I.

He is survived by his wife, Grayce, who is secretary to the Assistant State Highway Engineer—Bridges.

STATE OF CALIFORNIA

EDMUND G. BROWN, *Governor*

DEPARTMENT OF PUBLIC WORKS

PUBLIC WORKS BUILDING — 1120 N STREET, SACRAMENTO

ROBERT B. BRADFORD Director

FRANK A. CHAMBERS Chief Deputy Director
RUSSELL J. COONEY . . Deputy Director (Management)
HARRY D. FREEMAN . . Deputy Director (Planning)
T. F. BAGSHAW Assistant Director
JOHN H. STANFORD Assistant Director
S. ALAN WHITE . . Departmental Personnel Officer

DIVISION OF HIGHWAYS

J. C. WOMACK . . . State Highway Engineer, Chief of Division

CHAS. E. WAITE . . . Deputy State Highway Engineer
J. P. MURPHY . . . Deputy State Highway Engineer
J. W. TRASK . . . Deputy State Highway Engineer
J. A. LEGARRA . . Assistant State Highway Engineer
LYMAN R. GILLIS . Assistant State Highway Engineer
J. E. McMAHON . . Assistant State Highway Engineer
GEO. LANGSNER . . Assistant State Highway Engineer
E. R. HIGGINS Comptroller
FRANK E. BAXTER Maintenance Engineer
L. L. FUNK Planning Engineer
MILTON HARRIS Construction Engineer
F. N. HVEEM . . . Materials and Research Engineer
H. B. LA FORGE . Engineer of Federal Secondary Roads
SCOTT H. LATHROP . Personnel and Public Information
H. C. McCARTY Office Engineer
E. J. L. PETERSON . . Program and Budget Engineer
F. M. REYNOLDS Planning Survey Engineer
EARL E. SORENSON Equipment Engineer
W. L. WARREN Engineer of Design
G. M. WEBB Traffic Engineer
M. H. WEST . Engineer of City and Co-operative Projects
A. L. ELLIOTT Bridge Engineer—Planning
L. C. HOLLISTER . . . Projects Engineer—Carquinez
I. O. JAHLSTROM . . . Bridge Engineer—Operations
DALE DOWNING . . Bridge Engineer—Southern Area
R. R. ROWE . . . Bridge Engineer—Special Studies

Right-of-Way

FRANK C. BALFOUR . . . Chief Right-of-Way Agent
E. F. WAGNER . . . Deputy Chief Right-of-Way Agent
RUDOLF HESS Assistant Chief
R. S. J. PIANEZZI Assistant Chief
E. M. MacDONALD Assistant Chief

District IV

J. P. SINCLAIR . . Assistant State Highway Engineer

District VII

E. T. TELFORD . . Assistant State Highway Engineer

District Engineers

SAM HELWER District I, Eureka
H. S. MILES District II, Redding
ALAN S. HART District III, Marysville
L. A. WEYMOUTH District IV, San Francisco
R. A. HAYLER District IV, San Francisco
A. M. NASH District V, San Luis Obispo
W. L. WELCH District VI, Fresno
A. L. HIMELHOCH District VII, Los Angeles
GEORGE A. HILL District VII, Los Angeles
C. V. KANE District VIII, San Bernardino
E. R. FOLEY District IX, Bishop
JOHN G. MEYER District X, Stockton
J. DEKEMA District XI, San Diego
HOWARD C. WOOD Bridge Engineer State-owned Toll Bridges

CALIFORNIA HIGHWAY COMMISSION

ROBERT B. BRADFORD . Chairman and Director of Public Works
CHESTER H. WARLOW, Vice Chairman Fresno
JAMES A. GUTHRIE . . San Bernardino
ROBERT E. McCLURE . . Santa Monica
ARTHUR T. LUDDY . . . Sacramento
ROGER S. WOOLLEY . . . San Diego
JOHN J. PURCHIO Hayward
JACK COOPER, Secretary . . . Sacramento

DIVISION OF CONTRACTS AND RIGHTS-OF-WAY (LEGAL)

ROBERT E. REED Chief Counsel

GEORGE C. HADLEY Assistant Chief
HOLLOWAY JONES Assistant Chief
HARRY S. FENTON Assistant Chief

DIVISION OF SAN FRANCISCO BAY TOLL CROSSINGS

NORMAN C. RAAB Chief of Division
BEN BALALA Principal Bridge Engineer

DIVISION OF ARCHITECTURE

ANSON BOYD . . . State Architect, Chief of Division

HUBERT S. HUNTER . Deputy Chief, Administrative
EARL W. HAMPTON
Deputy Chief, Architecture and Engineering

HEADQUARTERS OFFICE

ARTHUR F. DUDMAN . . . Assistant State Architect
CHARLES M. HERD . . . Chief Construction Engineer
WILLIAM R. VICK
Principal Architect—Project Management
IAN LEE WATSON . Supervisor of Project Co-ordination
THOMAS CHINN . Supervisor of Scheduling and Control
ARTHUR J. RUIZ . Supervisor of Professional Services
HENRY R. CROWLE . . Administrative Service Officer
CARLTON L. CAMP Principal Architect
O. E. ANDERSON Principal Engineer
EDWARD G. SCHLEIGER Principal Estimator
CLIFFORD L. IVERSON . Chief Architectural Draftsman
GUSTAV B. VEHN Chief Specification Writer
ALLEN H. BROWNFIELD . Supervising Structural Engineer

LOS ANGELES OFFICE

TOM MERET Assistant State Architect
THOMAS LEWANDOWSKI
Supervisor of Project Management
JAMES A. GILLEM Principal Architect
CHARLES PETERSON . . Principal Structural Engineer
LESTER H. MULLEN Principal Engineer
RAYMOND J. CHEESMAN . Chief Architectural Draftsman
ROBERT J. PALEN Supervising Estimator
HENRY C. JACKSON . . Supervising Specification Writer

AREA CONSTRUCTION SUPERVISORS

THOMAS M. CURRAN Area I, Oakland
J. WILLIAM COOK Area II, Sacramento
CLARENCE T. TROOP Area III, Los Angeles

AREA STRUCTURAL ENGINEERS SCHOOLHOUSE SECTION

F. C. CHEESEBOROUGH (Acting) . Area I, San Francisco
M. A. EWING Area II, Sacramento
ERNST MAAG Area III, Los Angeles

printed in CALIFORNIA STATE PRINTING OFFICE 25100 9 60 41,500





The famous Cuesta Grade on US 101 just north of San Luis Obispo is one of California's most historical routes. Fra Junipero Serra used the pass in establishing his line of missions, and about this time the Spanish named it "Paso Cuesta." "Cuesta" means "hill" in Spanish.

The first work on the road was by the padres in 1800, but it was not until 1858 that the California "Court of Sessions" voted $1,000 for improvements. In 1876 San Luis Obispo County voted $20,000 for further improvements, and in 1895 the State Highway Commission voted to take the route into the state highway system.

In 1916 Cuesta was given its first oil surface—and in 1922 a contract was let for concrete paving. The photos show the road as it looked about 1915 before it was oiled, again as it looked in 1936, and as it looks today.



CUESTA GRADE

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CALIFORNIA Highways and Public Works



NOVEMBER-DECEMBER 1960

ANNUAL REPORT ISSUE

December 1, 1960

Edmund G. Brown
Governor, State of California

My Dear Governor:

I take pleasure in submitting to you the 14th Annual Report of the Division of Highways, Department of Public Works, prepared in compliance with Section 143, Streets and Highways Code. This report outlines the developments in California's Highway Program during the Fiscal Year 1959-60. Some of the more recent developments of importance are also included.

The Fiscal Year showed accelerated progress in new construction and improvement of existing highways. As of the end of the Fiscal Year an all-time high had been reached in number and volume of construction projects under way. Construction is expected to continue at a comparable rate during the current and the next Fiscal Year.

An increasing degree of cooperation between the State and local communities is being emphasized in the joint planning of traffic circulation systems and locating freeway routes. In keeping with the policy of the Legislature, the California Highway Commission continues to emphasize long-range planning and fiscal continuity in the budgeting of highway projects.

For the first time the Annual Report appears in California Highways and Public Works, the bi-monthly journal of the Department, instead of the separate publication issued heretofore. This is a significant improvement because it enables us to report to thousands more California citizens and public officials at a substantial reduction in cost to the State. Financial and statistical tables are contained in a separate publication available for those who are interested.

Respectfully,

Robert B. Bradford

ROBERT B. BRADFORD
Director of Public Works

December 1, 1960

Robert B. Bradford
Director of Public Works
State of California

Dear Sir:

Submitted herewith for your approval and transmittal to Governor Edmund G. Brown is the Fourteenth Annual Report of the Division of Highways. The report is prepared in compliance with Section 143 of the Streets and Highways Code. It covers the fiscal year ending June 30, 1960, and some later information is also included.

With this report a new format is being introduced. In the past all narrative and statistical material has been in one publication which was printed in limited quantity for official distribution. A condensed version of the report, designed for the interested citizen, appeared in *California Highways and Public Works* magazine and received wider distribution in reprint form.

The next logical step has been to include the entire text portion of the official report in the magazine, thus enlarging the distribution to include the interested public as well as all employees of the Department of Public Works. Financial statements, apportionment tables and contract statistics will be published in a seporate supplement and made available to interested persons.

The report is divided into three sections. The introduction contains general information about the organization, financing, and problems of the highway program in California. The second section is a summary of some of the significant construction which has been completed recently, or is now in progress or budgeted. This is followed by a resume of the activities of the various departments of the Division of Highways during the 1959-60 fiscal year.

Respectfully submitted,

J. C. Womack

J. C. WOMACK
State Highway Engineer
Chief, Division of Highways

California Highways and Public Works

Official Journal of the Division of Highways, Department of Public Works, State of California

Vol. 39 November-December Nos. 11-12



FRONT COVER—Looking east toward Donner Summit on US 40 (Interstate 80) showing a recently completed section of freeway between Hampshire Rocks and Soda Springs. Note the two roadways at different levels, with a stand of trees in the median. Elevation at this location is about 6,000 feet.

BACK COVER—View of the graving dock in Alameda where precast tube segments are cast for the Webster Street Tube, which is under construction to parallel the Posey Tube between Alameda and Oakland. This $17,400,000 project is scheduled for completion late in 1962.



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LESTER S. KORITZ, *Editor*

STEWART MITCHELL, *Associate Editor* JOHN C. ROBINSON, *Associate Editor*

HELEN HALSTED, *Assistant Editor*

WILLIAM R. CHANEY, *Chief Photographer*

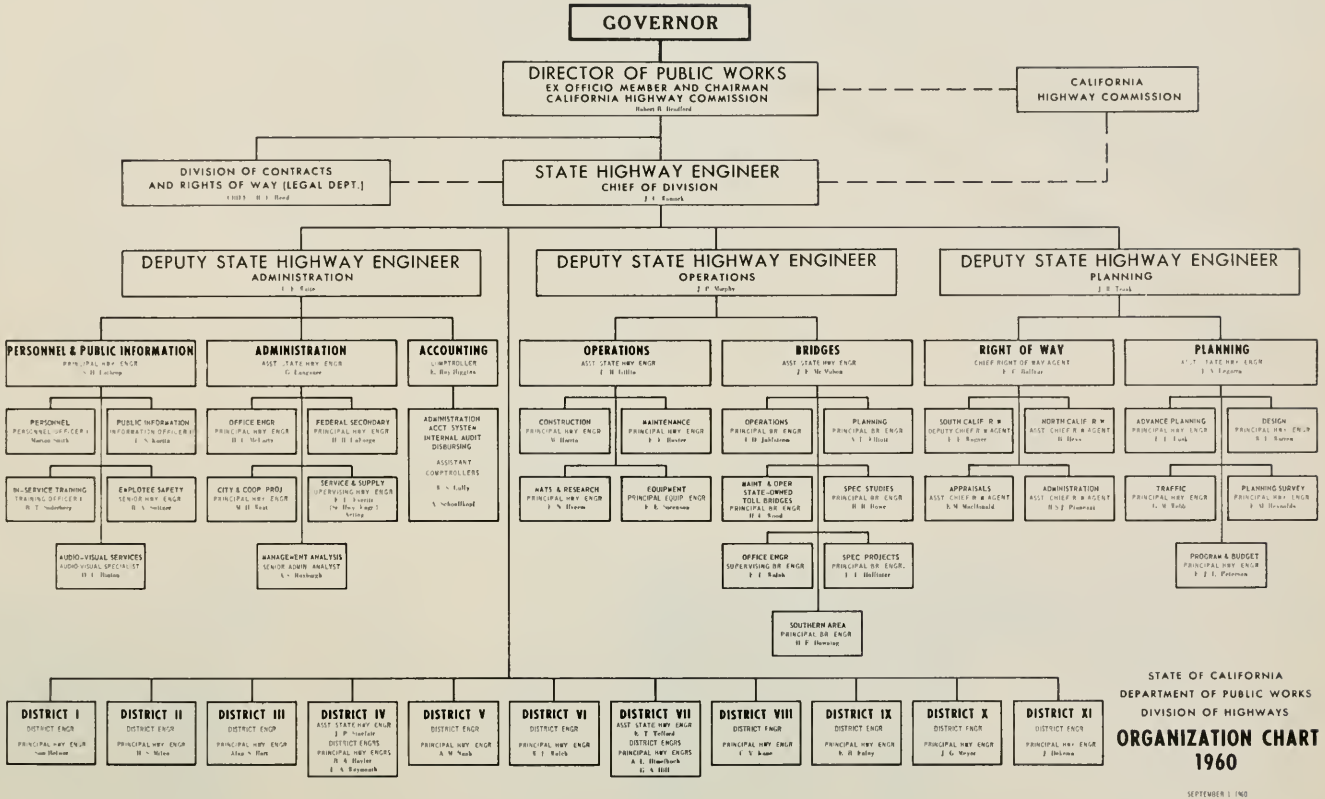
Editors are invited to use information contained herein and to request prints of any black and white photographs.

Address communications to: EDITOR,

CALIFORNIA HIGHWAYS AND PUBLIC WORKS

P. O. Box 1499

SACRAMENTO 7, CALIFORNIA



STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
DIVISION OF HIGHWAYS

ORGANIZATION CHART
1960

SEPTEMBER 1, 1960

STATE OF CALIFORNIA

DEPARTMENT OF PUBLIC WORKS

CALIFORNIA HIGHWAY COMMISSION

ROBERT B. BRADFORD, Chairman, Ex Officio

Member	*Residence*	*Date of original appointment*	*Term expires*
JAMES A. GUTHRIE	San Bernardino	September 14, 1943	January 15, 1961
CHESTER H. WARLOW	Fresno	September 14, 1943	January 15, 1961
ROBERT E. McCLURE	Santa Monica	January 18, 1954	January 15, 1962
ARTHUR T. LUDDY	Sacramento	February 16, 1959	January 15, 1963
ROGER S. WOOLLEY	San Diego	March 18, 1959	January 15, 1963
JOHN J. PURCHIO	Hayward	January 15, 1960	January 15, 1964

Secretary: A. J. COOPER

Assistant Secretary: GEORGE N. COOK

CALENDAR OF MEETINGS
CALIFORNIA HIGHWAY COMMISSION

July 1, 1959, to June 30, 1960

* July 22 and 23, 1959 Los Angeles

* July 24, 1959 San Diego

* August 26 and 27, 1959 Sacramento

September 4, 1959 Los Angeles
(Public hearing on freeway location, road VII-L.A-172-A, MonP,Mtbl, (Pomona Freeway) between Woods Avenue and Potrero Grade Drive.)

* September 22, 23 and 24, 1959 Sacramento

September 25, 1959 Livermore
(Public hearing on freeway location, road IV-Ala-108-A between Scotts Corner and US 50 near Livermore.)

* October 27, 28 and 29, 1959 Sacramento

* November 18 and 19, 1959 Los Angeles

November 20, 1959 Los Angeles
(Public hearing on freeway location, road VII-L.A-9-Irw, Azu,H,Gdr,I, between Duarte City Limits at Bradbourne Avenue and Glendora Avenue.)

December 1, 1959 Turlock
(Public hearing on freeway location, road X-Sta,Mer-4-A,Tur;D, between 3 miles north of Turlock and 3 miles south of Turlock.)

* December 16, 1959 Sacramento

* January 27, 1960 Sacramento

* February 17 and 18, 1960 Sacramento

March 23, 1960 Pleasanton
(Public hearing on freeway location, road IV-Ala,C.C-107-B,A, between Scotts Corner and about 2 miles north of Dublin.)

March 23 and 24, 1960 Oakland

* April 27 and 28, 1960 Sacramento

* May 25, 1960 Sacramento

May 25, 26 and 27, 1960 Tour
(May 25—Inspection of US 40 between Sacramento and Nevada State Line.)
May 26—Inspection of U.S. and State Sign Routes in Plumas, Lassen, and Modoc Counties.)
May 27—Inspection of U.S. and State Sign Routes in Modoc, Lassen, Tehama, Butte, and Yuba Counties.)

June 14, 1960 St. Helena
(Public hearing on freeway location, road IV-Nap-49-B,C, SHla, between 0.5 mile south of Rutherford and Ritchie Creek.)

June 15, 1960 South San Francisco
(Public hearing on freeway location, road IV-S.M-239-SBr, A,SSF,Clm,DlC, between 0.2 mile south of San Bruno Avenue and Route 56 at Alemany Boulevard.)

* June 23 and 24, 1960 Sacramento

June 24, 25, 26 and 27, 1960 Tour
(June 24—Inspection of US 99 in Merced, Madera, and Fresno Counties.)
(June 25—Inspection of State highways in Fresno, Kings, and Tulare Counties.)
(June 26—Inspection of Generals' Highway and State Highway Route 41 to Cedar Grove.)
(June 27—Inspection of State highways in Tulare and Kern Counties.)

* Regular meetings.

California Highway Commissioners (at upper table), staff members, and officials of the Division of Highways discuss highway problems with city and county representatives and private citizens at regular monthly meetings. Special hearings on freeway route matters are also held frequently.



PAST MEMBERS OF THE CALIFORNIA HIGHWAY COMMISSION

Name	Residence	Date of appointment	Termination of membership
Burton A. Towne*	Lodi	Aug. 2, 1911	Resigned Jan. 14, 1914
Charles D. Blaney*	Saratoga	Aug. 2, 1911	Resigned Mar. 1, 1917
N. D. Darlington*	Los Angeles	Aug. 2, 1911	Resigned Jan. 8, 1923
Charles F. Stern	Eureka	Jan. 15, 1914	Resigned Dec. 21, 1918
Henry J. Widenmann*	Vallejo	Mar. 1, 1917	Died Oct. 6, 1918
Charles A. Whitmore*	Visalia	Nov. 29, 1918	Resigned Jan. 8, 1923
Emmett Phillips*	Sacramento	Dec. 21, 1918	Died June 18, 1919
George C. Mansfield*	Oroville	June 24, 1919	Resigned Jan. 9, 1923
Harvey M. Toy*	San Francisco	Jan. 9, 1923	Resigned Jan. 3, 1927
Louis Everding*	Arcata	Jan. 9, 1923	Resigned Jan. 17, 1927
Nelson T. Edwards*	Orange	Jan. 10, 1923	Resigned Jan. 3, 1927
Ralph W. Bull*	Eureka	Jan. 6, 1927	Resigned Jan. 6, 1931
J. P. Baumgartner*	Santa Ana	Jan. 6, 1927	Resigned Jan. 6, 1931
M. B. Harris*	Fresno	April 18, 1927	Resigned Jan. 6, 1931
Joseph N. Schenck	Los Angeles	Aug. 19, 1927	Resigned Jan. 6, 1931
Fred S. Moody*	San Francisco	Aug. 19, 1927	Resigned Jan. 6, 1931
Earl Lee Kelly	Redding	Jan. 6, 1931	Resigned Oct. 18, 1932
Frank A. Tetley*	Riverside	Jan. 6, 1931	Resigned July 31, 1935
Timothy A. Reardon*	San Francisco	Jan. 6, 1931	Resigned May 7, 1936
Harry A. Hopkins*	Taft	Jan. 6, 1931	Resigned Oct. 14, 1937
Philip A. Stanton*	Anaheim	Jan. 6, 1931	Resigned Mar. 3, 1939
Dr. W. W. Barham	Yreka	Dec. 20, 1932	Resigned May 21, 1935
Ray Ingels	Ukiah	May 21, 1935	Resigned Oct. 4, 1935
C. D. Hamilton*	Banning	Aug. 1, 1935	Died April 24, 1936
H. R. Judah*	Santa Cruz	May 7, 1936	Resigned Oct. 5, 1937
Paul G. Jasper*	Fortuna	May 7, 1936	Resigned Mar. 3, 1939
William T. Hart*	Carlsbad	July 7, 1936	Resigned Mar. 3, 1939
Robert S. Redington	Los Angeles	Oct. 5, 1937	Resigned Jan. 27, 1939
Frank W. Clark	Los Angeles	Jan. 27, 1939	Resigned Mar. 10, 1939
Lawrence Barrett	San Francisco	Mar. 3, 1939	Resigned Jan. 11, 1943
Iener W. Nielsen	Fresno	Mar. 3, 1939	Resigned Jan. 11, 1943
Amerigo Bozzani	Los Angeles	Mar. 3, 1939	Resigned Jan. 11, 1943
Bert L. Vaughn	Jacumba	Mar. 3, 1939	Resigned Jan. 11, 1943
L. G. Hitchcock	Santa Rosa	Mar. 10, 1939	Resigned Jan. 11, 1943
Gordon H. Garland†	Sacramento	Jan. 11, 1943	Resigned Sept. 14, 1943
Mrs. Dora Shaw Heffner†	Sacramento	Jan. 11, 1943	Resigned Sept. 14, 1943
Miss Helen MacGregor†	Sacramento	Jan. 11, 1943	Resigned Sept. 14, 1943
Verne Scoggins†	Sacramento	Jan. 11, 1943	Resigned Sept. 14, 1943
William Sweigert†	Sacramento	Jan. 11, 1943	Resigned Sept. 14, 1943
C. Arnholt Smith	San Diego	Sept. 14, 1943	Resigned Jan. 1, 1949
C. H. Purcell*	Sacramento	Sept. 14, 1943	Resigned July 31, 1951
Homer P. Brown*	Placerville	Sept. 14, 1943	Resigned Oct. 26, 1951
Harrison R. Baker	Pasadena	Sept. 14, 1943	Jan. 15, 1954
Charles T. Leigh	San Diego	May 11, 1949	Jan. 15, 1955
F. Walter Sandelin	Ukiah	Sept. 14, 1943	Jan. 15, 1956
Frank B. Durkee	Sacramento	Aug. 4, 1951	Resigned Dec. 31, 1957
H. Stephen Chase	San Francisco	Oct. 30, 1951	Resigned Feb. 25, 1958
Fred A. Speers	Escondido	Jan. 21, 1955	Jan. 15, 1959
C. M. Gilliss	Sacramento	Jan. 1, 1958	Resigned Nov. 10, 1958
John O. Bronson	Sacramento	Feb. 26, 1958	Jan. 15, 1959
T. Fred Bagshaw	Mill Valley	Nov. 10, 1958	Resigned Jan. 4, 1959
Robert L. Bishop	Santa Rosa	Jan. 15, 1956	Jan. 15, 1960

* Deceased.
† Member of the Interim Commission.

California Highways–1960

THE NUMBER of cars and trucks in California has doubled in the past 12 years, and motor vehicle registration is still going up rapidly.

Californians are now driving more than 8,000,000 motor vehicles, roughly one car or truck for every two of the State's 15,800,000 citizens.

This big motor vehicle registration, larger than in any other state, reflects one of California's basic needs:

There must be safe, efficient, and well-planned highways in this State if the freedom of movement long identified with the California way of life is to be preserved.

The extent to which Californians rely on good roads is indicated by the fact that more than half of our cities and towns have no other type of transportation facility.

Recognizing the importance of adequate highways to serve both present and future generations, Californians have given continuing firm support to an extensive program of state highway improvement.

Through pay-as-you-go highway construction, California has developed a system of highways second to none. This State now has more miles of modern, toll-free multilane divided highway than any other state, about *2,562* miles completed or under construction.

Although great progress has been made, the State's need for bigger and better highways will be felt for many years.

Conservative estimates show that there will be at least twice as many motor vehicles in California in 1980 as there are today. Travel on our roads, streets and highways will be three times greater—climbing from an annual total of some 65 billion miles today to 200 billion miles in just 20 years.

Fortunately, California has already taken positive steps toward meeting this transportation challenge.

This State became the first to have an official long-range master plan for a statewide network of controlled access highways when the 1959 Legislature adopted the plan for the 12,500-mile California Freeway-Expressway System.

The plan calls for $10.5 billion in freeway and expressway construction during the next 20 years. It is the biggest public works program ever undertaken by any state.

This system of access-controlled highways will in 1980 connect all cities of 5,000 or more persons, carry 59 percent of the total motor vehicle travel, and serve every major industrial, agricultural, and recreation region. The system will provide estimated user savings of some $20 billion in 20 years.

Accident rates are lower on access-controlled highways. Thus, substantial safety benefits can also be expected, hundreds of lives will be saved and thousands of injuries prevented.

The plan is geared in 1980 population estimates of 31 million and to anticipated motor vehicle registration of 17,000,000.

Routes in the system have been designated by the Legislature in a general way. In most cases, only the termini have been named in law.

These general legislative descriptions will provide the guidelines for studies and public discussions leading to the adoption of more precise routes and decisions on details of design.

Thanks to the advance planning program which has been in effect in California for many years, routes have already been established by the California Highway Commission for 5,358 miles of freeways and expressways in the system. This total includes freeways and expressways already in operation or under construction and represents about 43 percent of the total freeway-expressway system mileage.

Access Control

Although California's 16,000-mile State Highway System includes hundreds of miles of conventional highway, the construction emphasis in recent years has been on modern highways with access control—*full freeways, expressways,* and *two-lane highways with access restrictions* ("two-lane freeways.").

Legally, all three types are "freeways;" that is highways with a varying degree of access control. To the average motorist, however, these highways are entirely different in appearance. (See page 11.)

As the terms are commonly used in California, a full freeway is the most advanced design. It is a divided highway with from four to eight lanes. Access is restricted to strategic locations where traffic may enter and leave the highway safely. There are no left turn movements in front of oncoming cars on freeways, and intersecting roads are taken over or under the highway by means of traffic separation structures. There are 850 miles of freeway in operation in the state and another 315 miles under construction.

An expressway is a four-lane divided highway with most of the features of a full freeway; but cross traffic, and sometimes private access, may be permitted at some locations. Plans are often made for converting expressways to full freeway standards later in keeping with the requirements of traffic. California now has 834 miles of expressway in operation or under construction.

A "two-lane freeway" is usually built in a rural or mountain area where the present traffic load is relatively small. These highways are much like ordinary two-lane facilities, except that access is planned to eliminate potential hazard and congestion. Also, enough width of right-of-way may be acquired for future additional lanes and a dividing strip.

Why Build Freeways?

Faced with ever-increasing traffic, California helped pioneer the freeway concept which is now generally ac-

cepted and endorsed throughout the world.

A freeway is the engineer's answer to the challenge of modern-day traffic volumes. One freeway lane will carry three times the traffic which can use a normal city street lane.

The tremendous capacity of our freeways is demonstrated by the fact that at least two freeway sections in Los Angeles are each carrying approximately 200,000 vehicles a day.

Probably the most significant freeway benefit, however, is safety. California's freeways for many years have had a better safety record than all other types of highways in the State.

For the past five years, the fatality rate on freeways has been about one-third the rate on conventional rural highways, and the overall accident rate has been about one-half the conventional highway rate (see chart on page 12).

Freeways promote safety for foot traffic, too. Pedestrians and bicycles are not permitted on freeways, and crossing structures and fencing keep children from darting into the fast moving traffic stream.

Freeways also offer an undiminishing return on the user-tax investment. Their capacity and safety characteristics are permanent. Freeways built 20 years ago in this State still are capable of handling the large traffic volumes for which they were designed, in contrast to the old style boulevards which were quickly choked and congested by unrestricted access.

It costs motorists less money to operate their cars on a freeway. Studies made in Southern California have shown a saving of more than a half-cent a mile on freeways, as compared to ordinary streets, in gasoline and upkeep alone. There are also great savings resulting from travel time reductions and reduced accident exposure.

Community Benefits

Experience shows that properly located freeways help local business by removing traffic from overburdened streets, thus easing business district congestion for the local people who do most of the buying. At the same time, freeway connections and interchanges, marked by large directional signs, make it easier to get to the business district.

Records of real estate transactions show that practically all commercial property along or near a freeway increases in value after the freeway is completed. This strengthens the local tax base and usually more than offsets the value of the land used for the freeway itself. Recent studies indicate that freeways also have a positive effect on the value of residential property.

After a freeway is built, residents frequently discover that they may once again drive from one side of their city to the other without encountering frustrating delays due to traffic congestion. They find that freeway crossing structures take them over or under a former traffic barrier.

With a freeway in operation, traffic noise and fumes generated by stop-and-go traffic are reduced because there are no stop signals on a freeway and traffic moves along smoothly.

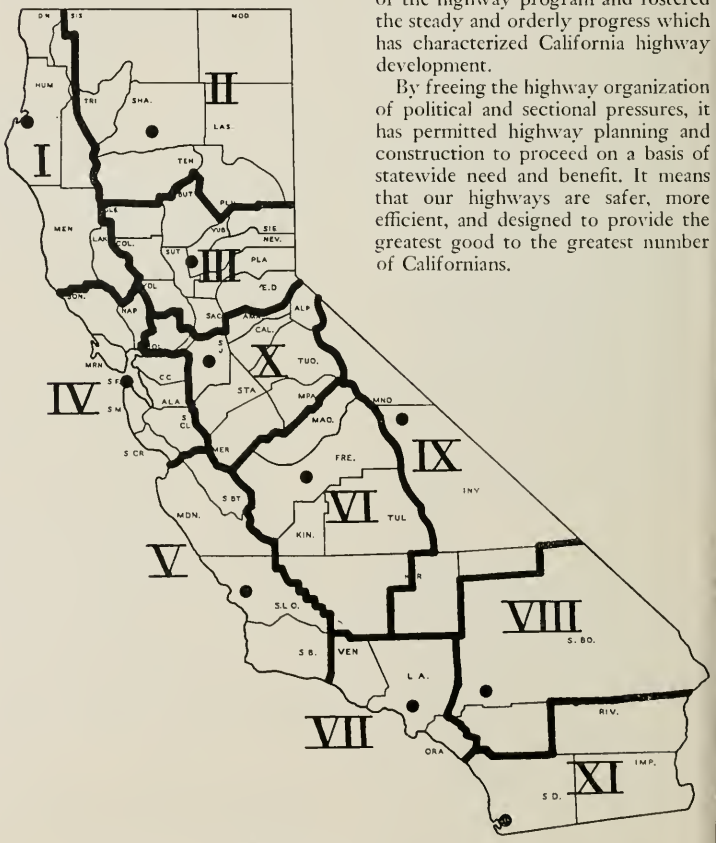
All these factors—permanent efficiency and safety and a wide range of auxiliary benefits—mean that freeways are making California cities, towns and rural areas better places in which to live.

Who Builds Freeways?

California legislators have delegated to the California Highway Commission the authority and responsibility for determining highway routes and allocating construction funds.

This long-standing legislative policy, which includes broad policy guidelines and statutory controls over fund allocation, has assured the continuity of the highway program and fostered the steady and orderly progress which has characterized California highway development.

By freeing the highway organization of political and sectional pressures, it has permitted highway planning and construction to proceed on a basis of statewide need and benefit. It means that our highways are safer, more efficient, and designed to provide the greatest good to the greatest number of Californians.



Map shows the 11 state highway districts. Circles denote district office locations.

It is the principal reason for California's position of pre-eminence in highway matters.

California Highway Commission

The California Highway Commission is a nontechnical board of business and professional men representing the people of the State at large.

Commissioners are appointed by the Governor, and the appointments are confirmed by the State Senate. Ex officio chairman of the seven-man group is the State Director of Public Works who serves at the pleasure of the Governor. The other six members are nonsalaried and serve four-year staggered terms.

In addition to budgeting highway funds and adopting freeway and highway routes, the commission also approves county primary road systems and authorizes the execution of deeds, condemnation proceedings, and right-of-way abandonments and relinquishments.

Division of Highways

The State Division of Highways, a unit of the Department of Public Works, handles the day-to-day administration of California's highway program, working in conformance with state law and policies of the Highway Commission.

The division is in charge of all state highway planning, design, right-of-way acquisition, construction and maintenance. Its activities cover the entire range of highway work from large scale freeway and bridge construction to small but essential maintenance jobs.

Chief of the Highway Division is the State Highway Engineer. He is assisted by a headquarters staff shown on the accompanying organization chart on page 2.

The State is divided into 11 state highway districts to provide for localized administration of the highway program (see map). These districts have approximately equivalent state highway mileage. The engineer in charge in each district is responsible for all phases of the highway program in his region.

District offices are in these cities:

District I
Eureka
430 West Wabash Avenue
Sam Helwer, District Engineer

District II
Redding
1657 Riverside Drive
H. S. Miles, District Engineer

District III
Marysville
703 B Street
Alan S. Hart, District Engineer

District IV
San Francisco
150 Oak Street
J. P. Sinclair, Assistant State Highway Engineer

District V
San Luis Obispo
50 Higuera Street
A. M. Nash, District Engineer

District VI
Fresno
1352 West Olive Avenue
W. L. Welch, District Engineer

District VII
Los Angeles
120 South Spring Street
E. T. Telford, Assistant State Highway Engineer

District VIII
San Bernardino
247 Third Street
C. V. Kane, District Engineer

District IX
Bishop
South Main Street
E. R. Foley, District Engineer

District X
Stockton
1976 East Charter Way
J. G. Meyer, District Engineer

District XI
San Diego
4075 Taylor Street
J. Dekema, District Engineer

All of the engineers, maintenance crews, technicians, statisticians and others who work for the Division of Highways are state-paid civil servants. They are dedicated to the service of all the citizens of the State and their constant goal is to provide the best possible value in safe, efficient highways for the taxpayer's dollar.

Highway Financing

The backbone of California's highway financing structure is the state gasoline tax of six cents a gallon. Four cents is applied to state highways, 1⅜ cents goes for county roads, and ⅝ of a cent for city streets other than state highways.

In addition to the gasoline tax, other sources of highway revenue in California are use (diesel) fuel taxes, transportation taxes, and motor vehicle registration and weight fees. (Revenue sources and distribution for road purposes are indicated in the chart on page 9).

About one-third of the total highway revenue in California comes from federal sources for expenditure on the various federal-aid highway systems of secondary, primary, urban and interstate highways.

The 1959-60 State Highway Budget contained an overall total of $610,712,000 of which $497,000,000 was for state highway construction purposes, including rights-of-way. The totals for the current 1960-61 budget are $569,244,000 and $452,785,000. As adopted by the Highway Commission in October, 1960, the record 1961-62 budget provides a gross total of $633,460,000 of which $509,078,000 is for state highway construction. (See article on 1961-62 budget on page 73.)

According to law, 55 percent of the money available each year for state highway construction and rights-of-way is allocated to the 13 southern counties. The remaining 45 percent goes to the northern 45-county group.

Each county is guaranteed a minimum share of the state highway construction funds in a specified period of years according to statutory formula.

In preparing the annual state highway budget, the Highway Commission must review hundreds of high-priority projects and attempt to choose those which will meet the most acute local and regional needs, comply with federal financing requirements, and at the same time fit logically into the long-range planning program for highway development on a statewide basis.

Thorough study and comparison of all available data, including comprehensive information on traffic volumes, accidents, population changes, road conditions and other factors, are required.

Preparing the annual budget is always extremely difficult as there is never enough money in a given year to do all the work that should be done.

The cities' ⅛ cent share of the gas tax, about $35 million a year, is dis-

tributed by the Division of Highways on a population basis.

The counties' 1⅜ cents share, along with a portion of the motor vehicle fees, amounts to about $92 million a year. These funds are distributed directly to the counties by the State Controller, and their expenditure for road purposes is administered by local board of supervisors.

Freeway Route Selection

Another difficult problem facing the Highway Commission and the Division of Highways is the selection of freeway routes. This is especially true when a proposed route passes through a built-up area.

In most cases nearly any route which might be selected will be unsatisfactory to some individuals, even though it offers the best service and the most benefits at a reasonable cost.

Early determination of freeway routes is essential to effective advance planning. Before design studies for any freeway project can proceed, of course, the location of the route must be decided upon.

Early determination of freeway routes also helps local city and regional planners by fixing permanently one of the major transportation elements of the area.

In California, freeway routes are selected according to policies and procedures which have been established and refined over a long period.

Object of these procedures is to insure painstaking study, careful consideration of all data, and complete public discussion of each possible route. California was one of the first states to make formal public hearings a definite step in the route adoption process.

Briefly, the route selection process is as follows:

General termini for state highways are named by the Legislature. Before possible alternate routes between these termini are even laid out, the Division of Highways gets together with city or county planners and traffic engineers to determine the area's needs and general plans. Local government agencies are notified that route studies are commencing. Informal public meetings are often held at this point to explain the problems involved and to obtain preliminary ideas.

Working in close co-operation with local technical staffs, the division conducts extensive traffic, engineering and economic studies. All local master plan information is carefully reviewed.

These studies provide the facts necessary for the projection and evaluation of the various alternate routes which might be considered.

Some alternates may be undesirable because they would adversely affect such "controls" as schools, hospitals, cemeteries, recognized landmarks, or recreational facilities.

Others will be unfeasible for engineering reasons, or because they would cost too much money in relation to the anticipated benefits. Still others will be unsatisfactory because they would give inadequate traffic service.

Finally, after study and restudy, the division boils down the possibilities to what are considered to be the most suitable choices from the standpoint of traffic service, effect on the community, economic influence, construction costs, and right-of-way cost.

These alternate routes are then subjected to intense public review at a series of meetings, both formal and informal, conducted by the Division of Highways.

Often these public discussions reveal a course for further study. Upon completion of such additional investigation, the State Highway Engineer recommends to the Highway Commission the route which appears to offer the best combination of traffic service and community or area benefits. Information on all other routes is also presented to the commission.

The Highway Commission will then take the matter of a routing under consideration.

In particularly difficult cases, the commissioners will decide to get first-hand information from local citizens by calling a public hearing in the area concerned.

In all cases, local governing agencies will be notified that if it is considered necessary or desirable, the Highway Commission will schedule a public hearing on the matter.

Even when no hearing is requested, the commission will announce its intention to adopt a route and withhold action for at least 30 days to allow time for submission of additional data and proposals.

All supplementary information presented at the public hearings, along with the data developed during the comprehensive studies and public meetings conducted by the highway division, is carefully considered in the commission's deliberations.

After the commission adopts a route, there is still another important step. Under California law, the local governing body and the State must enter into a freeway agreement setting forth the local roads and streets to be closed for the freeway. This gives local agencies a voice in design factors such as the location and type of interchanges and traffic separation structures to be provided.

Right-of-Way Acquisition

A total of 7,052 right-of-way transactions involving parcel acquisitions were concluded in the 1959-60 fiscal year. Of these, nearly 98 percent were negotiated settlements with property owners. About 2 percent were concluded through court proceedings.

One big reason for the large number of amicable right-of-way transactions is the division's policy of paying fair market value for required property. In dealings with the Division of Highways, owners can expect to receive the same amount for their holdings as they would from any other buyer under normal market conditions.

Landscaping and Planting

California's freeways are the scene of a large number of planting and landscaping projects each year. The last four annual budgets adopted by the Highway Commission have provided an aggregate of approximately $15,000,000 for such projects.

Freeway landscaping and planting projects are carefully worked out by the division's staff of landscape architects to serve both functional and beautification purposes.

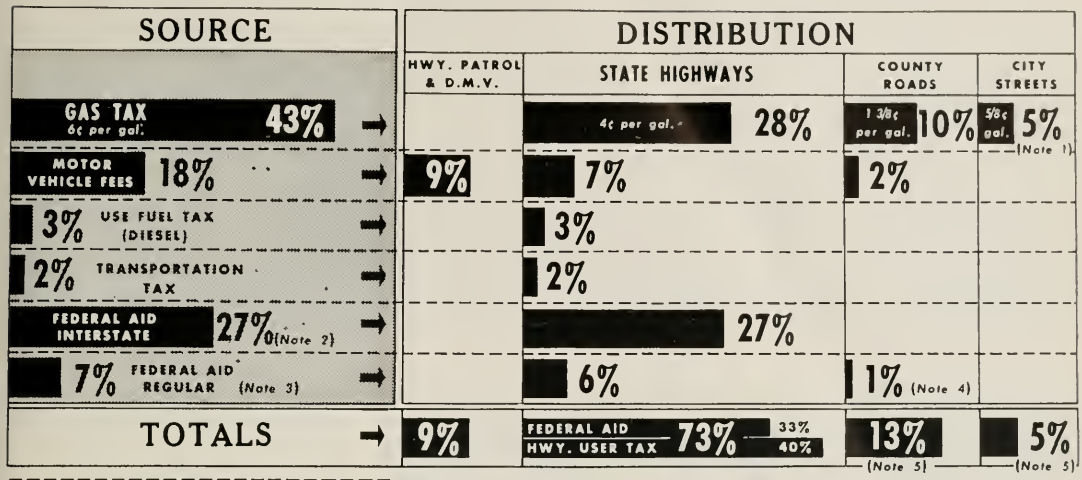
Planting of selected trees, shrubs, and plants not only enhances the appearance of a section of freeway, it also meets functional needs such as screening of headlight glare and noise and the prevention of erosion damage.

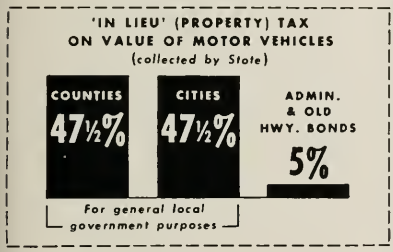
Care and control of roadside landscaping and other vegetation is a big

Highway User Taxes Including Federal Aid

Percentages based generally on 1961-62 Budget.

State of California
Department of Public Works
Division of Highways





NOTES

1. *State Highways within cities financed wholly by State and Federal funds.*
2. *Federal Aid Interstate must be matched 9% by State funds from above sources.*
3. *Federal Aid Primary, Secondary, and Urban must be matched 42%, mostly by State funds from above sources.*
4. *Does not include matching funds, up to $100,000 per county per year, from State Highway Fund.*
5. *Does not include $5,000,000 per year State highway matching funds for local railroad grade separations.*

and costly job requiring the services of hundred of landscaping specialists and tree workers. Extensive irrigation systems are required in some sections of the State to sustain roadside landscaping.

The division also carries out weed and fire hazard control programs designed to provide protection for agricultural and forest lands bordering state highways. These programs are often conducted in co-operation with other agencies.

Contract Data

During the 1959-60 fiscal year, the Division of Highways opened bids on 550 projects with an estimated construction value of $337,292,500 including construction engineering. Of these 550 projects, contracts were awarded for 510 projects with a value of $321,020,900; bids not in the best interest of the State were rejected on 26 projects. Fourteen other projects were to be awarded after the close of the fiscal year.

Contracts were also awarded during the year for nine projects, valued at $2,145,900, on which bids were received during the previous fiscal year. Informal contracts valued at $342,700 were approved.

The cost of right-of-way acquisition and utility relocation, exclusive of land clearance, overhead, and acquisition for other agencies, amounted to $111,046,982 for the year.

The total of $323,166,800 in contracts awarded during the year was made up of $265,979,000 for construction on state highways, $18,844,900 for work on county roads included in the Federal Aid Secondary System; and $38,342,900 for maintenance and emergency repair, and work for other agencies.

The State Highway System contracts of $265,979,000 consisted of $237,287,000 from the 1959-60 Budget and $28,692 from the 1960-61 Budget and were awarded under statutory provisions which permit the award of contracts as early as January 1, six months before the start of the fiscal year.

The contracted state highway work involved improvement of 1,514 miles of highways and construction of 373 bridges and separation structures.

CONSTRUCTION PROGRESS

Recently completed projects around the State have extended freeway system development in metropolitan areas, closed gaps in long stretches of freeway and expressway into cities, and eliminated outmoded sections in rural and scenic regions. Hundreds of important projects are now under construction or budgeted.

Southern California

In the Los Angeles Metropolitan area, the construction emphasis continues to be on three key routes in the region's projected freeway system—the Golden State, Santa Monica and San Diego Freeways.

These three interstate highways will provide alternate routes for the millions of motorists who travel the already operating freeways in this area.

A spectacular series of multimillion dollar projects is now in progress on the Golden State Freeway between the Santa Ana Freeway south of the civic center and north of San Fernando.

This work, along with current or completed construction on the Santa Monica Freeway, will complete the long-awaited east loop bypass of the crowded central freeways and the four-level interchange. This interchange, the world's busiest intersection, is now handling some 350,000 vehicles a day.

Now completed, under construction, or budgeted on the San Diego Freeway are 35 miles of eight-lane freeway between the Long Beach area and the San Fernando Valley.

Earlier this year, projects were completed on the Ventura Freeway in the San Fernando Valley and on the San Diego Freeway in Orange County to close the final gaps in 90 miles of continuous freeway from West Los Angeles to the San Diego County line. Construction is now in progress on a new section of freeway on US 101 in Ventura.

A 4.6-mile extension of the Harbor Freeway was recently opened to traffic, and construction is just getting started on another job which will complete this route from the four-level interchange to San Pedro, a distance of 22 miles.

Widening of heavily traveled sections of the San Bernardino Freeway is proceeding, and the Long Beach Freeway is being extended northward from the Santa Ana Freeway to the San Bernardino Freeway.

Work is starting on one project and a second is budgeted to provide another important connecting link between major freeways—the Ventura Freeway extension from the Hollywood Freeway to the Golden State Freeway.

One project is under construction and another budgeted to provide 16 miles of freeway on the Antelope Valley Freeway (US 6) east of Solamint.

In Riverside County construction is proceeding on the 7.7-mile Corona Bypass which connects with 3.4 miles of recently completed freeway in Riverside. Also under construction is 6.1 miles of freeway on US 60-70-99 between Beaumont and Banning. Construction is starting on a section of freeway on US 60 in Riverside.

Work is expected to start soon on two budgeted freeway projects on US 70-99 through Redlands, and a major bypass project is now under construction at Barstow.

Approximately 25 miles of interstate freeway are being built on US 91-466 east of Barstow, and another 27 miles are budgeted.

In the San Diego area the conversion of US Highway 80 from expressway to freeway standards has continued between San Diego and El Cajon, and work has started on the initial units of the future US 101 freeway in San Diego. One freeway project is under construction, and another budgeted on Sign Route 78 west of Escondido. A seven-mile freeway project is now in progress on US Highway 80 in Imperial County.

San Francisco Bay Region

The past year has been one of significant accomplishment in the San Francisco Bay area with several long-planned highway improvements completed and work getting started on several others.

Largest project now in progress is the $17,000,000 Webster Street Tube beneath the estuary between Oakland and Alameda. This tube parallels the present Posey Tube (see page 55).

A total of 6.5 miles of eight-lane freeway is now under construction or budgeted on the MacArthur Freeway (US 50) in Oakland, and work started recently on a third two-lane bore at the Caldecott (Broadway) Tunnel on Sign Route 24 at the east city limit of Oakland. Newly budgeted projects on Sign Routes 24 and 21 in Contra Costa County, along with work now in progress on the Benicia-Martinez Bridge and approaches, will provide 30 miles of continuous freeway between Oakland and US 40 at Vallejo. This includes the new freeway bypass of Walnut Creek.

The first unit of San Francisco's Southern Freeway was completed earlier this year, and additional work is continuing or budgeted on this route.

The last remaining gaps in 87 miles of continuous full freeway (Nimitz Freeway and US 40) between Los Gatos and Vallejo were eliminated with the opening this year of new freeway sections in Richmond and between Los Gatos and San Jose.

Construction recently began in Santa Clara County on the final projects to provide 49 miles of continuous freeway on the Bayshore Freeway (US 101 Bypass) between San Jose and San Francisco.

In the North Bay area emphasis continued on the Redwood Highway (US 101) with interchange work completed or underway at Greenbrae and north of San Rafael. Farther north work is starting on a freeway section from Santa Rosa to south of Healdsburg. This project and the new section north of Healdsburg will be part of approximately 20 miles of continuous full freeway on US 101.

Construction is now in progress on the final Joint Highway District 9 improvement on State Sign Route 1 south of Davenport in Santa Cruz County. Work is also in progress on 3.3 miles of expressway on Sign Route 17 north of Santa Cruz.

Central Coast Area

New freeway and expressway sections have been completed or are under construction on US 101 west of Santa Barbara, and funds are budgeted for an additional section of freeway in that city. The Ward Memorial Freeway serving the Goleta Campus of the University of California is also budgeted.

Work is in progress on the Santa Maria Bypass on US 101. This project, together with the current project at Pismo Beach, will eliminate the last gap in 100 miles of continuous freeway from Buellton to San Miguel.

A major improvement is nearing completion on the Orcutt Road (Leg-



TWO-LANE "FREEWAY"—Access-control through fencing and planned intersections makes this highway safer and more efficient than conventional two-lane roads without access restrictions.



Pictured here are a full freeway, an expressway, and a modern two-lane highway. Although these highways differ in appearance and design features, all three types are legally "freeways" because there is provision for access control in each case.



EXPRESSWAY (Above)—Four-lane divided highway with most full freeway features, but cross traffic may be permitted at some intersections as shown above.

FULL FREEWAY (Below)—Crossing structures, interchanges, and complete access control eliminate traditional traffic conflicts and make full freeways safer and more efficient than any other type of highway.



islative Route 2) south of Santa Maria, and work is continuing on a 12-mile project on State Sign Route 1 north of Cayucos.

Work has just been finished on a major interchange on State Sign Route 1 at Carmel, and extensive landscaping is now underway at this location.

The Soledad Bypass on US 101 in Monterey County was opened earlier this year, and work is in progress on 4.5 miles of freeway bypassing Greenfield. Newly budgeted bypass project at Gonzales will complete freeway and expressway development for 46 miles between King City and Salinas.

On Sign Route 156 a large scale relocation project is under construction at San Juan Bautista.

San Joaquin Valley

On US Highway 99 north-south travelers are now using the new eight-lane freeway on the Grapevine Grade in southern Kern County. The only remaining three-lane section on this route was eliminated with the completion of freeway construction north of Fresno.

US 99 freeway and interchange work is also under construction or budgeted in and approaching Bakersfield, near Lerdo, at McFarland, north of Pixley, north of Tulare, south of Fresno, in and north of Merced, at Modesto, at Stockton and at Lodi. Turlock is now the only major city in the San Joaquin Valley where US 99 is not completed, under construction or budgeted as a freeway. The route for the Turlock freeway has been adopted.

Work is in progress on 12 miles of expressway on US 466 east of Bakersfield, and funds are budgeted for additional freeway construction near Keene. Major projects are also underway on Sign Route 198 north of Lemon Cove and on Sign Route 33 near the Kings County line.

Progress on US 40

The construction emphasis which has been concentrated on US 40 as an Interstate route reached a climax late in 1959 when several new freeway sections were opened to traffic, in time for the 1960 Winter Olympics at Squaw Valley in February.

Today there are 93 miles of four-lane freeway and expressway on the 120 miles of US 40 between Sacramento and Nevada. The most recently completed section is the 7.8-mile stretch west of Emigrant Gap which was opened in November. Additional construction is now underway on 15.4 miles, including an initial unit of the Donner Summit relocation.

West of Sacramento, projects are under construction or budgeted on US 40 to eliminate the four-lane undivided Yolo Causeway, and to convert sections from expressway to freeway standards in the vicinity of Vacaville, Fairfield, Cordelia and east of Vallejo.

Sacramento Valley and US 99

On the north state portion of US 99 the new freeway at Dunsmuir was recently opened to traffic. Work is continuing on two projects farther south which will complete freeway and expressway development for 30 miles in the Sacramento River Canyon. A new freeway section is in operation at Weed and a new bridge over the Yuba River on US 99E at Marysville was completed this summer. A new bridge was also completed on Sign Route 12 at Rio Vista.

The 1961-62 Budget contains funds for US 99 freeway construction north of Red Bluff and between Cottonwood and Anderson.

Major projects on other north valley routes included the current relocation and causeway project on the Willow-Butte City Highway (Legislative Route 45) and construction of a new Bear River Bridge on Sign Route 24 at Rio Oso.

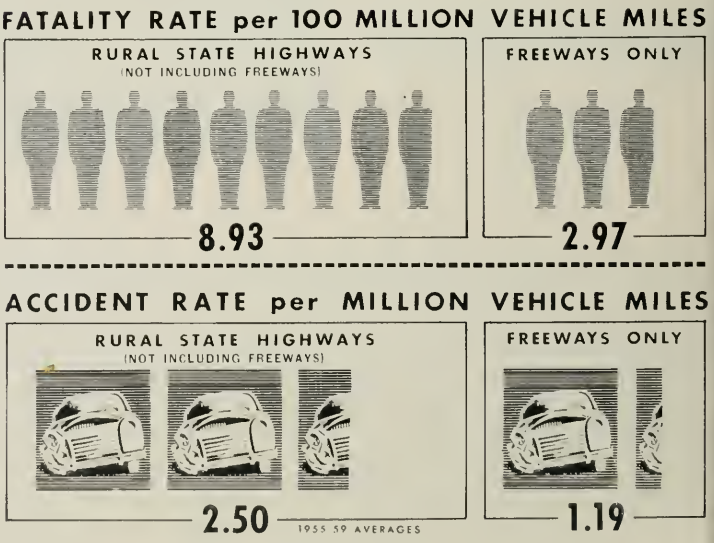
Foothill and Mountain Routes

Improvements on highways approaching or crossing the Sierra Nevada and the Cascades have been completed in recent months and additional work is now under construction or budgeted.

Opening of a large scale project in Alpine County completed the relocation over Luther Pass (Sign Route 89) and funds are budgeted for widening and realignment on Sign Route 88 (Carson Pass Highway) east of Pedler Hill.

Work is just getting started on reconstruction and realignment on Sign Route 4 (Ebbetts Pass Highway) between Angels Camp and Murphys.

Realignment is nearing completion on Sign Route 120 west of Yosemite Junction, Tuolumne County. Funds are budgeted for the initial two lanes of a future four-lane expressway on Sign Route 16 between Waites Station and Central House, Amador County, and for four-lane expressway



over Twain Harte Grade on Sign Route 108 east of Sonora.

On U.S. Highway 40 Alternate in Plumas County, a 4.3-mile realignment project is now under construction. Funds are budgeted for two US 40 Alternate freeway projects near Oroville. A new bridge over the West Branch of the Feather River is being built on US 40 Alternate north of Oroville.

Realignment is under way on sections of US 395 in the vicinity of Milford, Lassen County and south of Alturas. Funds are budgeted for two-lane highway on State Sign Route 89 between Dunsmuir and McCloud. East of the Sierra, US 395 is being relocated over Conway Summit in Mono County.

North Coast Region

The second unit of the Redwood Parks Freeway on US 101 is now under construction in the vicinity of Myers Flat, Humboldt County, additional freeway is budgeted to the south. Work is nearing completion on the parallel bridge over the Eel River south of Scotia.

Construction is also in progress on the 3.9-mile Fortuna Bypass, and on a new freeway section south of Eureka. Earlier this year a freeway was completed on US 101 between Little River and Trinidad.

About 15 miles north of Willits, a 4.9-mile freeway project is under construction. Funds are budgeted for an initial unit of future US 101 freeway north of Ukiah.

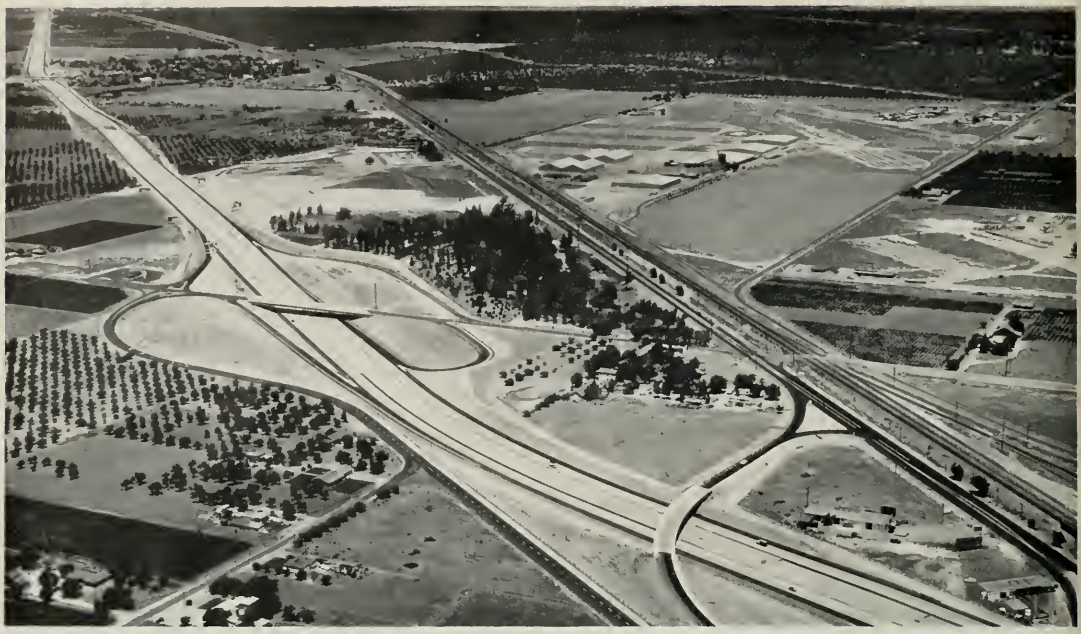
On U.S. Highway 299 work is continuing on a major improvement in Trinity County, and on the relocation around the future Whiskeytown Dam Reservoir in Shasta County.

Summary

As is evident from the foregoing resume of projects emphasis continues on the interstate system, but with considerable improvement taking place on other state highway routes. It is not possible to detail here the large number of projects providing for realignment, relocation, widening, new bridges and other improvements on many of the cross-state laterals, mountain highways and other routes important to the State's continuing economic growth. There has also been a continuation of projects providing much needed traffic relief on an interim basis, pending future freeway development, such as one-way street couplets, widening of major local streets, and signalization and channelization projects, usually under a cooperative arrangement with the city or county concerned.



This new bridge over the Sacramento River on State Sign Route 12 at Rio Vista was opened in April, 1960. River traffic passes under the lift-span between the towers (center).



The last section at three-lane highway an US 99 was eliminated in 1960 when this new four-lane freeway was opened narth at Fresno. Note old highway parallel to railroad at right.



Revision at the Mission Valley Interchange at the junction of U.S. Highway 80 and U.S. Highway 395 in San Diego was completed late in 1959. The project involved freeway construction on both routes including the traffic separation structure (center) which carries US 80 over US 395.

OPERATIONS

In the California Division of Highways organization, the functions of construction, maintenance, equipment and materials and research are administered under the direction of the Assistant State Highway Engineer—Operations. This section of the report covers the activities in these fields during the 1959-60 fiscal year.

CONSTRUCTION

The uncertainty about federal financing caused a sharp decrease in the number and value of going contracts during the first few months of the fiscal year. By the end of the year, however, the trend was back toward normal. The accompanying chart shows the total number and value of going contracts each month; the number of new contracts approved by the Attorney General each month; and the number of contracts completed, and accepted by the Director of Public Works. Minor contracts, day labor and bridge contracts are not included in this chart.

Although 29 projects costing more than $5,000,000 each were completed, contracts of less than $500,000 made up 85 percent of the total number completed during the year.

Special Projects

Early in the year, the Construction Department initiated a program of coring pavement sections on highway projects to make sure that plans and specifications are being met.

The Construction Manual was being completely revised. Publication was scheduled for the fall of 1960. At the same time work continued on the Equipment Reference Manual, which now includes 24 reports on construction equipment.

The study of causes of embankment failures was completed and a training film strip prepared. This training aid was shown in the districts beginning in the spring of 1960.

Construction Practice

Several projects included paving by slip-form method. This near-automatic process shows promise of providing superior pavement, although equipment and methods still must be perfected. Approximately 40 miles of pavement, 24 feet wide, have now been constructed by this method.

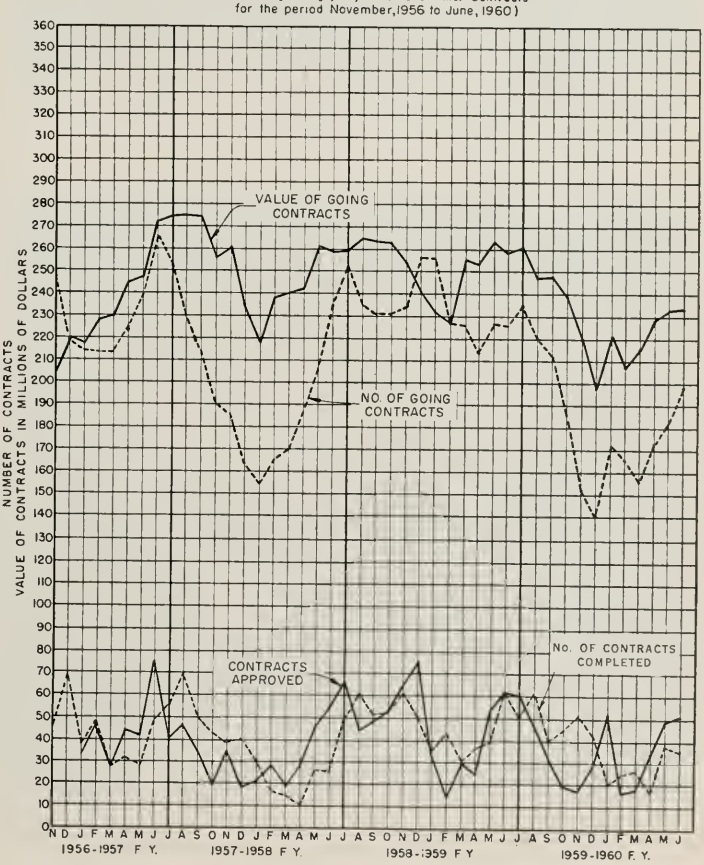
The 1960 Standard Specifications prescribe more exacting tolerances in the construction of the various layers of pavement structure. This in turn has prompted the equipment manufacturers to develop new or modify existing equipment to perform to these standards.

Equipment has been produced which automatically controls the cross-fall on asphalt concrete paving machines. Machines which spread base materials to a predetermined width and thickness have also been developed.

The automatic control on the paver is an adaptation of controls previously

TREND OF HIGHWAY CONTRACTS UNDER CONSTRUCTION

(Excluding Bridge, Day Labor and Minor Contracts for the period November, 1956 to June, 1960)





Work is now under way or budgeted on a spectacular series of large scale freeway projects on the Golden State Freeway portion of the future east-loop bypass around the central district of Los Angeles. One of these big jobs is this two-mile project in the San Fernando Valley between Roscae Boulevard and Lankershim Boulevard (foreground) near Sun Valley.



The slip-form method of paving (above), in which the usual form construction is not required, was used on several projects during the year. This new highway construction process is still in the developmental stage. About 40 miles of 24-foot pavement have been constructed by this method.

developed for use on motor graders. The base-spreading machine promises to replace the customary process of windrowing, watering, and blading the material with a motor grader. All that is required with the new procedure is to follow up the spreading machine with rollers.

Conservation Camp Projects

During the year, the Division of Highways and the Department of Corrections carried on joint operation of Conservation Camp No. 37 at Cedar Springs, Los Angeles County; Camp No. 41 near Happy Camp on the Klamath River in Siskiyou County; and Camp No. 42 near Lord Ellis Summit in Humboldt County.

In anticipation of the completion of work being done by Camp No. 37, preliminary studies were started on a site for proposed Camp No. 43 in the Kern River Canyon between Bakersfield and Isabella Reservoir.

Camp 37 forces were engaged in clearing, rough grading, installing culverts and constructing retaining walls on Route 62 between Islip Saddle, on the Angeles Crest Highway, and Crystal Lake. At the end of the year, rough grading had been completed on 5.6 miles of the 6½-mile section to be constructed.

Camp 41 construction work consisted of improving about nine miles of the Klamath River Highway, Sign Route 96, between Swillup Creek and Clear Creek, and about two miles between Wright Ranch and a half mile west of Happy Camp. The work included clearing, grading, placing of drainage facilities and masonry structures.

Camp 42 completed work on 3.8 miles of U.S. Highway 299 between Blue Lake and Berry Summit, and clearing way completed on an additional mile. Stabilization work and grading were in progress on this section.

At the end of the year, there were 71 inmates at the Cedar Springs Camp, 62 at the Clark Creek Camp, and 43 at the camp near Lord Ellis Summit.

MAINTENANCE

The Division of Highways has maintenance crews at more than 270 locations throughout the State. Their job is to protect the public's investment in the State Highway System and to keep the roads open when possible during storms, floods and other emergencies.

The total expenditure of all state highway maintenance work, including upkeep and repair of the Benicia-Martinez Ferry System, for the year was $34,539,300

New Routes Maintained

A total of 175.5 miles of former city streets and county roads was taken over for maintenance November 1, 1959. These routes were added to the State Highway System by the 1959 Legislature. The location, mileage and official route designation of these roads follow:

Lake County: from near Kelseyville to Lower Lake, 10.6 miles (Lak-243-A). *Humboldt County:* Martins Ferry to Johnsons, 17.4 miles (Hum-46-C). *Siskiyou County:* Hatfield to near Dorris, 19.4 miles (Sis-210-A). *Lassen and Modoc Counties:* Susanville to Adin, 68 miles (Las-20-Susv, C.Las,Mod-216-A,B,A). *Colusa and Glenn Counties:* Colusa to near Butte City, 17.7 miles (Col,Gle-88-Col,C,A), *Sutter County:* Tudor to near Nicolaus, 13.3 miles (Sut-245-A). *San Mateo County:* La Honda Junction to near San Gregorio, 15.2 miles (SM-107-A). *Monterey County:* Del Rey Oaks Connection, 2.1 miles (Mon-169-DRO). *Fresno County:* near Selma to Kings county line, 9.8 miles (Fre-135-A). *Amador County:* Ione cutoff, 2 miles (Ama-97-C).

Road Closures

During the summer and fall of 1959, forest fires caused several highway closures. A big San Bernardino Mountain fire required the closing of Route 59 north of Lake Arrowhead for eight days. Fire in the Sierra Madre Mountains above Pasadena closed Sign Route 2 for nine days in October. Numerous short road closures resulted from cloudbursts in desert and mountain areas in July and August.

A heavy preseason storm swept over the north and central portions of the State on September 18, 1959. More than nine inches of rain was reported at Big Sur on the Mounterey coast. Snowfall at the higher elevations closed Sonora and Tioga Passes for 24-hour periods and the Lassen Loop portion of Sign Route 89 for three and one-half days. Minor delays and one-way traffic controls were necessary as the result of storm-induced slides on the Redwood Highway (US 101).

Severe dust storms late in October forced the closing of portions of Sign Routes 33 and 80 in the vicinity of Mendota and a section of US 395 north of Mojave.

Major Slides and Storm Damage

After the intense September storm, precipitation during the subsequent fall period was very light until December. Extensive slide damage and flooding was not experienced again until February 7, 1960, when heavy rain in the northwest portion of the State caused the closure of the Redwood Highway north of Willits for 54 hours. Flooding along the Eel River prompted the Governor to declare that region a disaster area. The Trinity River lateral, the Klamath River Highway, and the Mendocino Coast Road were damaged during this storm period, and at some points two-way traffic was not restored until near the end of February. High water in the Russian River on February 8 forced the closing of Sign Route 12 at Guerneville for 36 hours. About eight miles north of Jenner on Sign Route 1, slipout and slide repairs required



California's highways are kept in safe and serviceable condition by some 3,600 maintenance employees of the Division of Highways. Maintenance equipment is located at some 270 major road maintenance stations throughout the State, including this new North Hollywood station near the Ventura Freeway.

the detouring of traffic during working hours.

A slide within the limits of an Interstate Highway Project on US 40 east of Baxter forced the closing of the westbound roadway on January 31, 1960, and necessitated detouring of westbound traffic via Sign Routes 20 and 49 to Auburn. Subsequent earth movement within the slide area undermined the eastbound roadway and required the construction of a temporary detour which served during the Winter Olympics in February.

Snow Removal

Snowfall was comparatively light during the 1959-60 winter season. The snow pack at Donner Summit on US 40 was only nine inches at the end of December. The maximum pack for the entire season at Norden, near the summit, was only 77 inches. Total snowfall for the season in this area was 296 inches.

The 1959-60 closure periods for the mountain pass highways from which snow is not removed in the winter were as follows: Lassen National Park (Sign Route 89), December 12 to June 4; Luther Pass (Sign Route 89), February 2 to March 23; Carson Pass (Sign Route 88), December 23 to May 12; Ebbetts Pass (Sign Route 4), December 13 to May 12; Sonora Pass (Sign Route 108), December 12 to May 12; Tioga Pass (Sign Route 120), December 12 to May 21; Monitor Pass (Sign Route 89), January 15 to April 11.

The Emerald Bay section of Sign Route 89, which is usually closed by snow for several months each year, was kept open most of the winter. There were only three relatively short closure periods, January 11-18, February 8-17, and February 18-20, plus closures of short duration in March.

The Angeles Crest Highway (Sign Route 2) between La Crescenta and Wrightwood was closed by snow at the higher elevations between January 10 and March 26, 1960.

The usual snow removal operations and the application of sand and salt as an aid to winter travel were carried out as required in the relatively mild weather. This function was aided by additional and improved equipment and more sand storage facilities at maintenance stations or strategic roadside locations.

The VIII Winter Olympic Games were held at Squaw Valley adjacent to Sign Route 89 February 18-28, 1960.

Under an agreement with the Olympic Organizing Committee, maintenance crews handled the snow removal on the local road connecting Sign Route 89 with the Olympic Village. The normal complement of snow removal equipment, including rotary plows, push plows and leaders, was available for this special assignment. This operation was favored by mild weather for most of the Olympic Games period.

Repair of Traveled Way and Shoulders

During the summer months, maintenance forces undertook a moderate program of road surface restoration including the reprocessing of asphaltic surfaces, application of leveling blankets, surface planing, seal coat application and restoration of base. Contracts financed from maintenance funds were let for screening seal coats, considered a replacement function. Approximately 60 miles of road surface were treated by the slurry seal coat process.

Maintenance Department personnel continued the review of road surface needs and prepared the annual resurfacing and seal coat program which totaled approximately $5,000,000. Construction funds were used to finance the resulting contracts.

Repair of spalled joints in Portland cement concrete pavements was undertaken using a mixture of epoxy resin and concrete aggregate. In a few instances depressions in the pavement were filled with the mixture. Areas so treated were opened to traffic in about three hours.

During the 1959-60 fiscal year, a total of $1,669,455 in maintenance funds was spent for repair work on roadways and shoulders including work in cities. This includes $1,472,820 (direct field cost or obligation) for restoration of 1,187 miles of traveled way and 1,041 miles of shoulders. Also included in the total is $196,635 for seal coat (screenings contract) on 144 miles of roadway. The restoration program includes penetration treatment, reprocessing, sand and slurry seal coat and base restoration.

During the year limited use was made of the mud jacking principle of pavement restoration. The work was confined for the most part to locations on bridge approaches, and $28,760 was expended for this type of repair.

Roadside Cleanup

Cleaning of litter from roadways and roadsides by both hand methods and mechanical means was continued during the year with an increase in expenditure for this function. Appreciation of the problem and co-operation by the public in the attempt to keep the roadsides clean were evidenced by the use of some 600 50-gallon litter cans positioned throughout the State. About 1,000 signs were in place reading, "Unlawful to dispose of litter or garbage along highway—Maximum penalty $500 fine—and 6 Mos. Imprisonment."

Bridge Repair and Maintenance

Recommendations for repairs and and painting of bridges on the State Highway System were prepared by the Bridge Department. The direct field cost of the repairs undertaken during the fiscal year and considered a maintenance fund obligation was $714,361, including $333,342 under contracts and $381,019 for work performed by state and city forces.

Benicia-Martinez Ferry

Operation of the Benicia-Martinez Ferry was continued through the year with only minor interruptions in service due to mechanical failures. In November the ferry was drydocked for four days to permit annual repair and Coast Guard inspection. During that period foot passengers were carried in a rented boat, on a shortened schedule.

Ferry traffic showed a slight decrease from the previous year with 126,250 vehicles and 164,823 pedestrians transported during the 12-month period.

Maintenance of State Highways in Cities

At the end of the fiscal year, maintenance funds were being expended



This slide (foreground) threatened to block U.S. Highway 40 near Baxter at a time when heavy traffic was expected for the 1960 Winter Olympics at Squaw Valley. Four lanes had been in operation on a temporary basis with the partly completed freeway carrying eastbound traffic (left) and the old highway handling westbound vehicles. The slide was successfully cleared from the old highway and a detour was constructed around the danger area on the eastbound lanes. The freeway has now been completed on this section.

on state highways in 333 incorporated cities. The direct field cost for maintenance of state highways in cities for the year was $7,534,366 including $5,951,914 for work by state forces and $1,582,452 for work by city forces.

Trees and Vegetation

All types of natural and planted roadside vegetation within the state highway right-of-way were cared for according to standardized practices. Trees and landscaped areas were maintained by personnel trained for this specialized maintenance activity.

An expanded program of weed spraying and grass mowing served to improve the appearance and safety of roadside areas. Brush was controlled by mowing and selective spraying.

Fire hazard control work was continued on roadsides where extreme or unusual hazard to adjoining property existed. Soil sterilization, discing or blading were the methods employed to develop barren roadside strips to stop or impede the spread of fire.

Noxious weed control along state highways, as in the past, was accomplished largely by crews working under the direction of county agricultural commissioners. Several maintenance fund contracts, serving to re-

duce the overload of work on the permanent tree maintenance crews, were let to firms specializing in the trimming, balancing and removal of roadside trees.

Many mature plantings, which did not have to be watered in previous years, required three or four waterings during the summer of 1959 as the result of light rainfall the previous winter.

Classes of instruction in subjects related to the care of roadside areas and the supervision of the special crews employed for that work were conducted at a number of locations throughout the State by Headquarters Landscape Maintenance representatives.

Lighting and Traffic Signals

As in previous years, the number of illumination units and traffic signals requiring maintenance increased during the fiscal year. Notable increases were in illuminated signs, where the number of fluorescent lamps increased by 1,570 or 27.5 percent for a new total of 7,288, and in all highway illumination type fixtures where the number of lamps increased by 4,370 or 18.4 percent for a new total of 28,029.

At the same time, the number of traffic actuated controllers in traffic signal circuits being maintained by state forces increased by 79 or 6.7 percent for a new total of 1,258, while fixed time controllers decreased by four or 0.6 percent for a new total of 645. This reflected to some extent a shift from fixed time controllers at intersections to the traffic-actuated type; however, the reduction was also partly due to the relinquishment to cities and counties of some fixed-time controller intersections.

Travel time and costs involved in servicing remote installations of lighting, signal or electrical devices have become an item of concern, and have prompted the establishment of additional crew headquarters and shops for this service. Electrical shops capable of complete maintenance of all types of electrical devices in service on highways in their respective areas have been established at Bakersfield and Salinas.

Highway Signs

Expenditure of maintenance funds during the year for maintenance and replacement of existing signs amounted to $601,264.

The following sign work was performed by maintenance crews during the year:

New installations (all funds)	16,091
Replacements	9,456
Signs washed and cleaned	50,908
Signs repaired	39,666
Signs straightened	12,287
Signs relocated or re-erected	12,687
Signs removed	6,497
Sign posts painted	48,683
Total	196,275

During the year approximately 1,000 of the new type lightweight aluminum signs were erected. These signs consist of a single aluminum sheet or two aluminum sheets with a paper core that can be erected as vertical or horizontal panels depending on size. The light weight of these signs simplifies installation and repair, as lighter and less costly equipment is required.

Several state highway routes were named by the 1957 and 1959 Legislatures, and appropriate signs have now been installed. Signs carrying the various highway names were placed on these routes: Shoreline Highway (Sign Route 1) from north of Sausalito to Leggett, Mendocino County; Redwood Highway (US 101) from the Golden Gate Bridge to Oregon; Cabrillo Highway (Sign Route 1) from Las Cruces, Santa Barbara County, to San Francisco; El Camino Real (US 101) from Mexico to San Francisco; Pacific Coast Highway (US 101 Alt.) from north of San Clemente to north of Oxnard.

During past years, the Maintenance Department at the Sacramento headquarters has processed requisitions and issued purchase orders for the major portion of highway signs. As of May 1, 1960, the function of issuing purchase orders was transferred to the Service and Supply Department. The Maintenance Department continued to review requisitions for all signs until July 1, 1960, at which time the Traffic Department assumed this responsibility in connection with all new signs. The Maintenance Department continued to review requisitions for replacement signs.

Striping and Pavement Markings

Experimentation with a new type traffic striping unit, developed by the Equipment Department, was continued. Thirteen large stripers of the conventional type were still used throughout the State, however, to place the major portion of the striping on approximately 11,150 miles of road. Traffic striping in the larger cities was performed by city forces. The direct field expenditure of maintenance funds for traffic striping and pavement markings, not including work performed by cities, was $1,181,378.

Use of white thermoplastic paint for crosswalks and pavement markings at heavy traffic locations was continued. Observations of earlier applications of this material indicate a probable service life of six to eight times the life of a painted stripe. Similar markings of traffic lacquer have required renewal three or four times a year. Use of thermoplastic product reduces traffic inconvenience and contributes materially to the safety of personnel due to the reduced exposure to traffic hazards at heavily congested intersections.

Communications—Radio and Teletype

The division's statewide radio system was further improved and expanded during the year. New radio facilities were installed at Downieville and Sierraville to provide radio coverage of the Yuba Pass portion of Sign Route 49. A new radio station was also installed on Silver Spear Mountain, Inyo County, to improve radio coverage on US 395 between Bishop and Mojave and on Sign Route 190, in the Death Valley area.

Installation of additional microwave facilities at Marysville, Sacramento, and Banner Mountain, Yuba County, was completed. At the end of the fiscal year work was under way to extend this microwave system to Truckee to provide mobile radio coverage of the future routing of US 40 over Donner Summit. In addition, this link will provide instantaneous

radio contact between the district office at Marysville, and the maintenance stations at Nevada City, Sacramento, Whitmore, Kingvale, and Truckee without interference to the mobile radio system.

The changeover from two-frequency operation to four-frequency operation was complete, thus eliminating considerable interference between districts. Each of the 11 districts now operates on a radio frequency different from an adjoining district. The changeover of the entire radio system from wide-band to narrow-band operation in compliance with Federal Communications Commission regulations was also completed.

At the end of the fiscal year 178 radio stations, 25 microwave stations, and 1,025 mobile radio units were in service.

Operation of a private line teletypewriter system consisting of 18 stations and connecting the districts with offices at Headquarters in Sacramento was continued. During the winter months special teletypewriter receivers are connected to this system to disseminate road and weather information to newspapers, automobile clubs, radio and television stations, wire services, trucking concerns, and other interested parties.

Outdoor Advertising

The administration of the Outdoor Advertising Act has been carried out on the same basis as in the past, being financed entirely from revenue received from licenses and permits.

The 1959 Legislature amended the Act to increase structure and sign permit fees to $2 and 50¢ respectively, effective January 1, 1960; and license fees to $65, effective July 1, 1960, to provide sufficient revenue to restore operations and enforcement to an adequate level.

The number of outdoor advertising operators licensed for 1959-60 was 843, as compared with 820 the previous fiscal year, and 853 in 1957-58.

Gross receipts from permits issued for 989 signs and 30,978 structures in 1959-60 was $85,942, reflecting the increase in permit fees. A total of $79,795 was paid for 539 sign permits and 39,615 structure permits in 1958-59.

Permits

About 12 percent fewer transportation permits were issued in 1959-60, as compared with the previous year, as the result of new permit provisions established by the 1959 Legislature. The new regulations made it possible for transporters of oversize trailer coaches to obtain an annual permit instead of the single trip permits formerly required.

The Los Angeles and San Francisco Districts, in that order, continued to handle the largest volume of extra-legal hauling permits, accounting for some 44 percent of the statewide total. The San Bernardino District replaced the Fresno District in third position for volume.

Military certifications processed during the fiscal year averaged 28 cases per month with emphasis on the missile program and related construction activities.

The encroachment permit function also experienced a slight reduction of some 6 percent, with the two metropolitan districts handling about one-half of the total of all 11 districts.

The number of encroachment permits issued in 1959-60 was 13,415 as compared to 14,269 in 1958-59 and 13,956 in 1957-58. A total of 92,156 transportation permits was issued in 1959-60. For the two preceding fiscal years the totals were 104,353 and 87,009 respectively.

Truck Weighing Facilities

A new truck weighing facility located on US 99 north of the Grapevine Canyon portion of the Ridge Route near the community of Wheeler Ridge was completed during the year. This installation replaced a scale yard maintained for many years near Fort Tejon and removed during recent relocation of the highway.

At the new location a large paved yard area suitably illuminated to permit night operation was also constructed. At designated locations within the yard, personnel of the California Highway Patrol will check the registration certificates and test the brake equipment of trucks. Space was also provided to permit cargo loaded improperly to be unloaded, shifted or transferred to other vehicles. A "return lane" to the platform scale was also delineated, to permit reweighing of trucks prior to release from the yard.

Maintenance Stations

Improvement of existing maintenance station facilities and construction of new yards were continued during the year. The Division of Architecture completed plans and prepared to advertise for the construction of dormitory, warehouse and sand storage buildings at the Whitmore and Kingvale Maintenance Station yards on US 40. The first phase of construction, consisting of fueling



Division of Highways maintenance crew repairing the pavement base on a section of the Bayshore Freeway in San Mateo County.



This new section of eight-lane freeway over the Grapevine Grade on US 99 in Kern County was opened June 28, 1960. The photograph shows a northerly view through the canyon toward the San Joaquin Valley.

facilities and equipment garages, was started at these yards during the previous fiscal year. The Division of Architecture continued the preparation of plans for a new station at Santa Barbara and began planning new facilities at Lee Vining in Mono County.

Negotations were started for new sites in the mountain communities of Forest Glen, Kyburz, Long Barn, Coulterville, Groveland, Weldon, and Wrightwood. In the valley and coastal areas new sites were considered at Geyserville, Sebastopol, Point Reyes, Esparto, Dixon, Mendota, and Taft. Arrangements were made for a new site at Oceanside.

Plans were developed for new maintenance station facilities at Beecher's Corners, Mountain Pass and Midway Wells. These projects were ready for contract at the end of the fiscal year. Construction drawings were completed for a new station to be built during the following fiscal year in Lassen County near Adin, and for a large sand storage building at Grasshopper Flat on the Susanville-Adin highway and a combination sand storage and warehouse building at the Susanville yard.

New yard facilities were completed at Ramona and a superintendent's office was constructed at Escondido.

Contracts were awarded for new maintenance station facilities at Orleans, Hayfork, South San Francisco, Madera, Merced and North Hollywood. Cottage construction was undertaken at the Gibson, Pulga, Buckhorn, Crestview and Shoshone Maintenance Stations, and a contract was let to build a superintendent's office at the Burney Maintenance yard.

Construction was started on major buildings of the equipment garage or warehouse type at stations located at Napa, Walnut Creek, Fremont, Benton, Fillmore, Moorpark, Torrance, and El Centro.

Expenditures for maintenance stations and radio system structures for the fiscal year totaled $1,872,129 including $214,948 for land acquisition, $1,520,052 for improvements, (does not include funds spent by Division of Architecture), and $137,129 for repair and replacement.

MATERIALS AND RESEARCH

The principal work of the Materials and Research Department is inspecting and testing materials used in highway construction. The department also carries on research projects for the improved use or testing of materials and conducts special investigations. Some materials testing and inspection is done for other governmental agencies.

Staff engineers represent the Division on 32 national road materials committees of various technical organizations such as the Highway Research Board, American Society for Testing Materials, American Concrete Institute, and the American Association of State Highway Officials. During the past year, 16 technical papers were prepared and presented at meetings of these organizations.

The work of the department is carried on by four operating sections and an administration and service section.

Administration and Services

The Administration and Services Section handles such activities as photography, drafting, training, report review, accounting, shops and other general office functions. It also reviews all district reports pertaining to materials and studies research data developed by other agencies.

Three training sessions for senior engineers from the construction and design departments were conducted during the year. These one-week courses covered all phases of highway materials testing. The teaching staff comprised personnel from all laboratory sections.

Arrangements were made for tours or study courses for 60 foreign engineers representing 24 countries, as well as for division employees and visiting engineers from other governmental agencies and private engineering firms.

Foundation Section

The building of multilane highways in mountainous terrain presents some of the most challenging problems in modern earth-work construction.



Drilling operation in Orange County to obtain soil samples for testing purposes.



A sand volume test is used in checking compaction qualities on a highway construction project in Southern California.

Long-radius curves must be carved out of steep hillsides and this puts heavy loads on barely stable slopes. In valley and bay areas, compressible saturated clays and peats in highway foundation areas challenge the ingenuity of the foundation engineer.

The tools of soil mechanics and geology are used to investigate and evaluate foundation conditions for highways. More than 11,000 lineal feet of drilled exploration borings were made during the year at 21 different locations. Geological and soils studies were conducted to gather information needed for cut slope design, foundation stability, landslide analysis, and location of material sites.

Where applicable, geophysical methods were employed to obtain useful subsurface information at low cost. The results of seismic surveys were used more extensively than in past years as a guide for judging the characteristics of excavation materials. During the year, 53 foundation investigation reports were submitted to the districts and the Division of Architecture. In addition, the department drilled more than 7,000 lineal feet of horizontal drains for stabilization of slopes, and cleaned and rehabilitated more than 20,000 lineal feet of existing drains.

Most foundation troubles are associated with water and hydrostatic head; hence, the removal of excess water from foundations and subgrades is one of the prime requisites of a stable highway. Vertical sand drains are installed as a means of stabilizing swampy foundations.

An experimental sand drain installation in a fill at the west approach of a proposed new bridge across the Napa River on Sign Route 48 west of Vallejo will provide needed data on soft foundation soils and the performance of vertical sand drains. Instrumentation for obtaining this data include piezometers, settlement devices, and reference monuments. "Slope Indicators" of the type used in the study of the Palisades landslides were also installed for the purpose of obtaining information on soft-soil deformation under stresses imposed by the weight of the fills.

A large number of settlement devices have been installed on construction projects to determine the required settlement period for embankments at structure approaches, and to provide information on the rate and magnitude of settlement in natural ground under embankments.

For a number of years the Foundation Section has been testing and evaluating various graduations of filter materials. These tests, and field observation of the performance of filter materials, have indicated the need for a cleaner filter material than has been specified in the past, and the 1960 Standard Specifications contain revised grading requirements which should result in a more permeable filter material. Studies of filter material are being continued in order to establish more reliable criteria for design.

Quality tests of all aggregates used in highway construction are performed by the Foundation Section. The new policy of the Bureau of Public Roads, requiring additional testing of materials used on federal-aid projects, has added to the workload of the laboratories. During the month the new policy had been in effect, before the end of the year, more than 500 soil and aggregate samples were received and tested for this single purpose.

An improved portable sand equivalent shaker, developed by the Idaho Department of Highways, was modified for use in the control of aggregate quality. Research is continuing to develop test procedures for evaluating the amount and effect of degradation of mineral aggregates used in highway construction. The section cooperated with the Corps of Engineers and the State Department of Water Resources in studying the effect of various soil samplers on sample disturbance.

New emphasis was placed on a procedure that permits considerable speed-up of compaction testing by allowing the use of wet soil weights instead of dry weights. Use of the "wet weight" method reduces the time needed for field control of compaction. A special program was started to determine the strength of compacted embankments.

Pavement Section

The Pavement Section conducts routine testing and research work in

connection with asphalts, asphalt paving mixtures, base materials, subbases, and special field investigations.

Deflection measuring crews perform tests on many miles of highways for the purpose of determining the support capacity of the existing roadway and, hence, the most economical type of repair. A traveling deflectometer was placed in service during the year.

Field crews cut core samples from selected projects to measure the thickness of the various layers making up the pavement structure.

In conformance with Bureau of Public Roads requirements, an engineering audit of materials and construction was established to insure construction according to plans and specifications. This program, required for all projects which involve some federal financing, has been extended to include wholly state-financed projects. In the first month of operation, 236 lane miles of new construction were examined by coring and sampling.

Research work concerning the resiliency of soils continued. A considerable amount of field work was performed in connection with studies on permeability of asphalt pavements and on skid properties of pavements.

Approximately 6,500 routine tests were performed on base and pavement materials and some 309,000 tons of asphaltic products were checked for compliance with specifications.

Structural Materials Section

The Structural Materials Section inspects, samples, and tests manufactured and fabricated materials for use on contract projects. Since this work is expanding rapidly with the increase in contract work, it has been necessary to establish formal procedures for such inspection work. This was done this past year by issuing Volume III of the Materials Manual.

During the year, inspectors checked and released huge quantities of fabricated and manufactured materials. This includes more than 28,000,000 pounds of structural steel, 99,000,000 pounds of reinforcing steel, 350,000 feet of concrete pipe, more than 1,000,000 feet of guard rail, and about 640,000 feet of corrugated metal pipe.



On-the-job test to determine the unit weight of portland cement concrete.

Approximately 1,250 tests were made on materials ranging from welded girders to light bulbs. Field investigations, special tests, and research were continued on various structural materials, signals and lighting, commodities, signs, and traffic safety devices.

The mechanical and electrical development unit worked on special mechanical devices and instrumentation, particularly for the traveling deflectometer and the profilograph. Several acoustical investigations, were made including a followup investigation of the noise problem at the Hollywood Bowl for comparison with a similar study made in 1954.

The physical testing laboratory completed research aimed at minimizing the possibility of corrosion of post-tensioned steel during the curing process; continued tests to evaluate various types of bearing pads for prestressed girders; and began a testing program on the efficiency of high-tensile bolted connections for sign structures.

The welding laboratory completed development of the Fillet Weld Tee Bend Test, a new procedure for gauging the quality of automatic and semiautomatic fillet welds used in structural steel fabrication. A survey of welding on completed bridge structures was made to accumulate



These testing laborotory technicians are using the stabilometer, a special device to determine stability of pavements.



All materials used in highway construction are subjected to rigid tests to make certain the state's high standards are being met. Even incandescent globes (above) used in signal lamps must undergo the scrutiny of department technicians.

data for possible revisions and improvements in design and specifications, and a comprehensive manual of instructions for welding inspectors was nearly completed.

The corrosion laboratory, having found a correlation between the service life of metal culverts and environmental factors such as the pH and resistivity of the soil and water, worked out a detailed test procedure for predicting probable metal culvert service life. Used with judgment and due consideration for other factors (such as condition of existing culverts), this method appears to be a useful aid in the selection of culvert types or protective measures against corrosion.

The electrical laboratory evaluated several new types of lighting and signal equipment, and completed preliminary instrumentation for a project in which steel reinforcing bars, with strain gauge and lead wires attached, will be placed in the concrete of an undercrossing. Stresses in the bars will be determined by analyzing data from the instruments located in a trailer at the project. It is expected that this investigation will provide useful data for future use in bridge design.

The commodity test group recommended changes in the specifications and design of median barriers on the basis of laboratory tests and field observations. New test methods and specifications for various types of signs and sign materials were developed. Numerous routine and special tests were performed on commodities and on signs, reflectors and other traffic control and safety items.

Technical Section

The Technical Section comprises units assigned to chemistry, portland cement and portland cement concrete. Each has performed an increased number of routine acceptance tests of construction materials.

The chemical laboratory has prepared specifications for green bridge paints of the color selected by the Bridge Department.

The chemical unit has formulated, furnished and applied epoxy based adhesives and binders in repair work.

Specifications have also been prepared for furnishing and installing plastic reflective pavement markers. These markers are being used in increasing number for lane delineation on pavements. They have the advantage of providing improved night visibility to vehicle operators as compared to the usual reflectorized painted strip.

The cement laboratory has co-operated with the National Bureau of Standards and committees of the American Society for Testing Materials in the improvement of methods of testing portland cement. It has continued work on the development of a simple on-the-job test to determine the quality of sands used in portland cement concrete.

Specifications for concrete pavements now provide for a variation in the percentage of portland cement in order to obtain more nearly constant strength. Cement requirements in paving concrete are determined for each aggregate source.

The concrete unit has conducted extensive investigations on the effect of admixtures on the volume change in concrete.

Both the chemical and concrete units have been evaluating the quality of cement-treated bases and concrete pavements as revealed by core samples taken after completion of construction.

District Laboratories

Each of the 11 state highway districts has a district laboratory. These laboratories do most of the preliminary foundation exploration and locate potential sources of materials. On the bases of exploration and tests, a materials report is prepared which includes recommendations for cut-slopes and special foundation treatments, if required. Recommendations are also made concerning the thickness of layers of materials required for the structural design of the pavement.

Routine check tests are made on samples of materials furnished by contractors to see if they comply with specifications.

The Equipment Department's 12 main shops, with their subshops and resident mechanic's facilities, are the responsibility of the equipment engineer.

The shop organization controls the repair of all equipment, and the design and construction of specialized equipment.

The department headquarters has four branches, administration, operations, research and training, and accounting.

Shops

The chief function of the shops is repair and maintenance. New and unusual equipment is designed and developed. Other equipment, not available on the open market, is constructed. Some equipment has to be specially adapted for highway use.

Equipment Repairs

In the past year, equipment repairs cost about $3,600,000. These repairs included everything from brake relining to the complete overhaul of heavy motor graders and rotary snow plows. Heavy repairs are scheduled to avoid conflict with operating work schedules. Thus, most snow removal equipment is overhauled during the summer months, and grading machinery is worked over in the winter. Resident mechanics, assigned to outlying locations, frequently make field repairs, saving the expense of transporting equipment to the main shops.

Special crews repair such items as the machinery on movable bridges and on state-operated ferry boats, and ventilation equipment in tunnels.

Equipment Design and Construction

A new traffic line marker was designed during the year. A pilot model was manufactured at the headquarters shop in Sacramento and is being tried in one of the districts. This new traffic line marker enables the operator to work in the cab of the truck, instead of in a sulky pushed by the truck. Upon completion of the tests, other similar machines will be constructed to replace the sulkies as they wear out.



The operation and maintenance of the State Highway System requires a wide variety of heavy equipment including these vehicles which are being serviced and repaired at the Equipment Department truck repair shop in Sacramento.



Rotary snowplows go into action each winter to clear California's mountain pass highways. The Division of Highways operates three new-type heavy-duty rotaries mounted on motor graders (above) and 53 truck-mounted rotary plows.

Seattle Public Library
JAN 20 1961

The department also remodels old equipment such as asphalt kettles, certain push-plows, and specialized truck bodies.

Surplus Equipment

Much of the specialized equipment is developed from US Government surplus material obtained through the Bureau of Public Roads. For example, some of the trucks now used to water roadside planting formerly carried aviation gasoline for military aircraft. These tanks were obtained and rebuilt at a fraction of the market cost. Many shop tools have also been obtained in this way.

Administration

The Administration Section handles all of construction, maintenance and repair of shop buildings, purchasing, safety programs, and equipment rentals.

Work has started on new buildings or expansion and modernization of older buildings at six equipment shops —in Sacramento, Redding, Los Angeles, San Jose, El Centro and Indio.

Each shop has a stores department which stocks necessary automotive and heavy equipment parts not readily available from dealers. Parts no longer needed are returned for credit to the various vendors. A statewide catalogue of all critical and excess stocks is maintained as an inventory control device. By means of this catalogue, Shop 11 in San Diego may be able to obtain a hard-to-get item from Shop 10 in Stockton.

Operations

The Operations Section prepares specifications for equipment purchases, recommends the purchase and disposal of equipment, inspects pressure vessels, and maintains lubrication manuals.

During the year, specifications were prepared for the purchase of 145 different equipment units costing about $3,900,000. A total of 940 units was purchased, including 176 passenger cars, 386 truck, and 378 miscellaneous units.

Depreciated and worn out equipment is disposed of at auction or by negotiation with other government agencies. During the year 738 units, with an original capital cost of $2,173,603, were disposed of for $328,020, a favorable return of 15.1 percent.

Two staff members are qualified as pressure vessel inspectors licensed by the Division of Industrial Safety. In the past year, they examined and certified for use 1,247 Division operated air pressure vessels.

Research and Training

The Research and Training Section investigates problems involving equipment operation and construction, and the use of fuels and lubricants. Presently under study are a decelerator for motor graders, and methods of reducing transmission problems on heavy equipment. A standardized air cleaner was adopted during the year, and the specifications for lubricants are constantly reviewed.

A 22-month training program on lubrication and preventive maintenance was completed during the year. A total of 2,575 state employees received instruction in 164 separate classes at 80 locations in the state. Maintenance Department employees took part in training sessions on the mechanical features of various equipment units.

SUMMARY

The following is a summary of operation for the last two 12-month periods ending as indicated below:

	June 30,1959	*June 30,1960*
Equipment repairs	$3,514,245.01	$3,644,496.54
Miscellaneous expense	627,153.65	582,293.33
Administration and other expense	918,387.69	958,586.96
Depreciation expense	2,222,288.72	2,463,367.02
Total expense	$7,282,075.07	$7,648,743.85
Total income	$6,841,724.95	7,410,123.22
1959-1960 excess of expense over income		$238,620.63

Inventory: The original investment in equipment is as follows:

TRUCKS AND PASSENGER VEHICLES	
All trucks, ½ ton to 10 ton	$11,214,098.00
Buses, jeeps, and station wagons	298,330.00
Passenger automobiles	2,950,540.00
MAINTENANCE AND CONSTRUCTION EQUIPMENT	
Motor graders	$4,317,373.00
Rotary snowplows (truck mounted)	1,439,704.00
Rotary snowplows (motor grader mounted)	131,632.00
Shovels, power	505,032.00
Loaders	1,656,523.00
Tractors	885,613.00
Snowplows, push	583,397.00
Compressors	357,705.00
Miscellaneous other equipment: rollers, mixers, trailers, pumps, drills, mowers, etc.	3,647,837.45
Total	$27,987,784.45

ADMINISTRATION

The Assistant State Highway Engineer, Administration, exercises control over the following functions: Office Engineer; Federal Aid Secondary and County Co-operative Projects; City Co-operative Projects; Service and Supply; and Management Analysis.

OFFICE ENGINEER

The Office Engineering function includes the review and co-ordination of plans and estimates prior to the award contract; preparation of special provisions, proposal forms and other contract documents; advertisement of projects and supplying plans and proposal forms to prospective bidders; processing contract documents after receipt of bids; continuous review, development and production of standard specifications in final form, in collaboration with other departments of the division; administrative control over project expenditures to insure compliance with the budget; the programing of federal funds and securing of reimbursement for construction and right-of-way expenditures on federal aid projects on the State Highway System; right-of-way engineering, including preparation of condemnation, relinquishment, and abandonment documents and director's deeds for action by the Highway Commission; and industry contacts.

Other functions under the Office Engineer's jurisdiction include reports and statistics, prequalification records; and general files.

Budget and Project Control

Engineering control of the state highway budget entails assuring that provisions and amounts specified in the budget are observed; preparation and processing of contract documents; preparation of financial documents submitted to the Highway Commission; issuance of work orders for all construction; and keeping of contract records.

During the year, 308 financial votes were prepared for commission action, 504 projects were advertised for bids, and 515 projects were determined to be satisfactory for contract awards.

In addition to the major contract work, the financing of 329 minor and informal contracts, having a total value of $744,000, was cleared. A total of 2,706 individual work orders was processed by this section to provide for all activities of the Division of Highways, except those pertaining to maintenance and to city projects financed from the budget provisions for major city streets.

Plans and Estimates

This unit is responsible for the review and co-ordination of plans and specifications prior to advertising projects for bids, and for the accuracy of progress and final contract pay estimates, preparation of various state highway maps, and various related engineering functions.

Plan and estimate review is kept ahead of advertising schedules and a backlog of reviewed projects is maintained so that all funds may be obligated as they become available.

The number of contracts under way varied between 202 and 309 during the fiscal year. Progress pay estimates approximately equal to the number of active contracts are reviewed and checked each month.

Specifications

Specifications were prepared for 550 projects for which bids were received during the 1959-60 fiscal year. Additional specifications were also prepared for future projects to expedite advertisement when funds become available.

The new 1960 Standard Specifications which have been in use since January 1, 1960, are operating satisfactorily.

New Standard Special Provisions are being prepared as new materials and procedures are developed. The most recent major specification change, since the new Standard Specifications were published, is the development of the slip-form method of constructing concrete pavement. Other items of work for which Standard Special Provisions have been prepared include concrete cribbing, metal bin-type retaining walls, roadside signs, cast-in-place concrete pipe, aluminum chain link fence, cable-chain link barrier, blocked-out metal beam barrier, and reflective pavement markers.

Reports and Statistics

Statistical records pertaining to the value of the 519 highway construction contracts awarded during the fiscal year were maintained by the Reports and Statistics Unit. From these records the California Highway Construction Cost Index was prepared quarterly and information furnished regarding construction cost behavior. Weekly and monthly reports were also prepared showing the value and progress of budgeted and other programs, and of other projects for which bids were received. Factors for seven construction items have been determined for use in forecasting future materials requirements.

Right-of-Way Engineering

The Right-of-way Engineering Section works in close co-operation with the Right-of-way Department. It also works closely with the Division of Contracts and Rights-of-way (Legal Division) for advice in preparing complex condemnation resolutions, and in satisfying legal requirements in relinquishing superseded highways, frontage roads, and other local roads.

Right-of-way requirements for the year called for engineering review and preparation of 392 condemnation resolutions involving 2,248 parcels of property. This represents about 5 percent increase in the volume of work.

Of the 392 resolutions, 130 were of a complicated nature involving amendments to previous resolutions in order to provide for such factors as utility replacements and entry permits.

Property no longer required for state highway purposes is transferred

to other ownership, either by abandonments, relinquishment, or director's deeds. To accomplish these transfers of ownership it was necessary to prepare 28 abandonment votes and 123 relinquishment votes for California Highway Commission action. The total length of superseded highways, frontage roads, and other local roads relinquished or abandoned during the fiscal year was 293 miles.

A total of 741 director's deeds was certified for correctness of property descriptions preliminary to processing for Highway Commission action.

Prequalification of Contractors

Prequalification is required of all contractors who desire to bid on state highway projects estimated to cost more than $15,000. The prequalification rating, representing the maximum bidding capacity for each of the several types of work which a bidder is capable of undertaking, is established from a review of each contractor's statement of experience and financial condition.

During the year, the total number of contractors prequalified to bid on the various types of state highway construction decreased from 1,045 on July 1, 1959, to 987 on July 1, 1960. The combined bidding capacity of these 987 prequalified contractors is $2,363,226,000, which is $248,000,000 more than it was a year ago. In determining this total bidding capacity, a maximum of $20,000,000 for individual ratings is used and ratings in excess of that amount are entered at the $20,000,000 figure, as the bidding capacity of the larger firms is not concentrated in this State.

The following tabulation gives the number of contractors prequalified by the Division of Highways on June 30, 1960, arranged by the several brackets of bid ratings.

Rating	*No. of contractors*
$10,000,000 and over	73
5,000,000 to $10,000,000	131
2,500,000 to 5,000,000	207
1,500,000 to 2,500,000	282
1,000,000 to 1,500,000	371
500,000 to 1,000,000	511
250,000 to 500,000	680
100,000 to 250,000	819
50,000 to 100,000	947
15,000 to 50,000	987

Bids and Bidders

The average number of bidders per project was at a satisfactory level during the year. The highest monthly average of 10.0 was in January 1960. The low of 4.1 was in October 1959. The average for the year was 6.1 bidders.

The contracts awarded during the fiscal year have been arranged in eight value ranges as shown in the following table. Included in the table is the number of projects making up each bracket and the percentage it bears to the total. Similar information is shown regarding the value of the projects in each group. (The "over $5,000,000" category includes two bond-financed Benicia-Martinez Bridge contracts totaling $14,238,400.)

Range	*Number of projects*	*Percent*	*Value of projects*	*Percent*
Under $50,000	244	47.0	$4,728,015	1.8
$50,000 to $100,000	65	12.5	4,579,310	1.7
100,000 to 250,000	86	16.6	13,582,746	5.0
250,000 to 500,000	51	9.8	18,118,004	6.7
500,000 to 1,000,000	26	5.0	18,541,270	6.9
1,000,000 to 2,500,000	17	3.3	26,429,433	9.8
2,500,000 to 5,000,000	15	2.9	58,996,132	21.9
Over $5,000,000	15	2.9	124,330,726	46.2
Totals	519	100.0	$269,305,636	100.0

Construction Cost Index

The California Highway Construction Cost Index reflects the changes in highway construction costs. The index is founded upon weighted average contract prices for seven principal construction items in place, all referred to the base year of 1940 having a value of 100.

The California Highway Construction Cost Index for the four quarters of the fiscal year showed a variation in costs between a low of 219.8 and a high of 260.3. The year began with an index value of 260.3 in the third quarter of 1959, dropped to 229.1 in the fourth quarter, dropped again to 219.8 in the first quarter of 1960, and then climbed to 251.6 in the second quarter of 1960.

The item of roadway excavation showed the greatest fluctuation, from a low quarterly average of $0.44 to a high quarterly average of $0.71 per cubic yard, an increase of 61 percent. The high price of $0.71 was primarily the result of a bid price of $1.70 per cubic yard on one large US 40 project in a hardrock area of the Sierra-Nevada Mountains during the second quarter of 1960.

The accompanying graph shows a comparison between the California Index, the Bureau of Public Roads Composite Mile Index, and the Engineering News-Record Construction Cost Index. The small fluctuations of the past several years in the Composite Mile Index appear to indicate a continuance of a trend toward stabilization of prices. The Bureau Index, based on a greater number of projects on a nationwide basis, does not reflect the pronounced rises and falls to be found in an index where local conditions are a controlling factor, as in the California Index. The Engineering News-Record Construction Cost Index, which includes many large construction projects other than highway work, continues to show a steady rise throughout, except for the slight sags which occurred in 1948 and during the fourth quarter of 1959.

Continued improvement in construction methods and strong competition have contributed to the reduction in highway construction costs in recent quarters. Actual increases in wages, materials and cost of financing which occurred during the last year were reflected in an upturn of the California Index during the second quarter of 1960, the final quarter of the fiscal year.

THE CALIFORNIA HIGHWAY CONSTRUCTION COST INDEX

Year	*Cost index*
1940	100.0
1941	125.0
1942	157.5
1943	156.4
1944	177.8
1945	179.5
1946	179.7
1947	203.3

Year	Cost index
1948	216.6
1949	190.7
1950	181.2
(1st quarter 1950, 160.0)	
1951	225.0
(4th quarter 1951, 245.4)	
1952	225.9
1953	215.2
1954	193.5
(2d quarter 1954, 189.0)	
1955 (1st quarter)	189.3
1955 (2d quarter)	212.4
1955 (3d quarter)	208.6
1955 (4th quarter)	212.6
1956 (1st quarter)	219.5
1956 (2d quarter)	255.9
1956 (3d quarter)	249.1
1956 (4th quarter)	252.1
1957 (1st quarter)	277.7
1957 (2d quarter)	266.9
1957 (3d quarter)	237.5
1957 (4th quarter)	262.1
1958 (1st quarter)	241.8
1958 (2d quarter)	231.0
1958 (3d quarter)	228.5
1958 (4th quarter)	238.5
1959 (1st quarter)	216.1
1959 (2d quarter)	270.4
1959 (3d quarter)	260.3
1959 (4th quarter)	229.1
1960 (1st quarter)	219.8
1960 (2d quarter)	251.6

Progress in Highway Development

In the 13 years following passage of the Collier-Burns Highway Act in 1947, contracts covering a total of 15,113 centerline miles of state highway construction have been placed under way. By fiscal years, this centerline mileage is as follows:

	Miles
1947-48	646
1948-49	657
1949-50	730
1950-51	530
1951-52	502
1952-53	580
1953-54	1,170
1954-55	1,970
1955-56	1,670
1956-57	2,317
1957-58	1,548
1958-59	1,512
1959-60	1,281

The above total figures cover work on the State Highway System only. In addition, during the 1959-60 fiscal year, the Department of Public Works awarded contracts for the construction of 233 miles of highways on the Federal-aid Secondary County Road System and work on state park roads.

Of the 15,113 miles of state highway improvements during the last 13 years, 2,201 miles were divided highways of four or more lanes including both freeway and expressway types. The divided highway construction undertaken in each of the 13 years is shown in the following tabulation.

	Miles		Miles
1947-48	106	1954-55	267
1948-49	107	1955-56	187
1949-50	151	1956-57	341
1950-51	115	1957-58	158
1951-52	99	1958-59	244
1952-53	92	1959-60	145
1953-54	189		

On June 30, 1960, including projects under construction, there were 1,042 miles of the full freeway type of highway on the state system; that is, divided highways with no cross traffic or left turns at grade.

Various highway and street mileages, with which the Division of Highways is directly or indirectly concerned, are shown in the accompanying table.

	Miles	Miles
Total State Highway System (including portions of city streets and FAS System)		16,327
Highways proposed for construction where roads do not exist		2,298
Constructed state highways		14,029
Federal-aid System		
Primary rural (12-31-59)	8,003	
Primary urban (12-31-59)	1,359	
Total		9,362
Federal-aid Interstate System (included in above)		2,175
Federal-aid Secondary System (12-31-59)		
On state highways	3,414	
On county roads	7,800	
Total		11,214
County primary road system (12-31-59)	23,526	
Other county roads (12-31-59)	44,802	
Total county maintained system		68,328
City streets (estimated 12-31-59)		28,614
City streets on State Highway System		1,610

The following tabulations give the number of contracts with mileage by types which were put under way between July 1, 1959, and June 30, 1960, and the total mileage in the State Highway System on December 31, 1959, by type of surface both inside and outside of cities.

CONTRACTS AWARDED BETWEEN JULY 1, 1959 AND JUNE 30, 1960
State Highway System

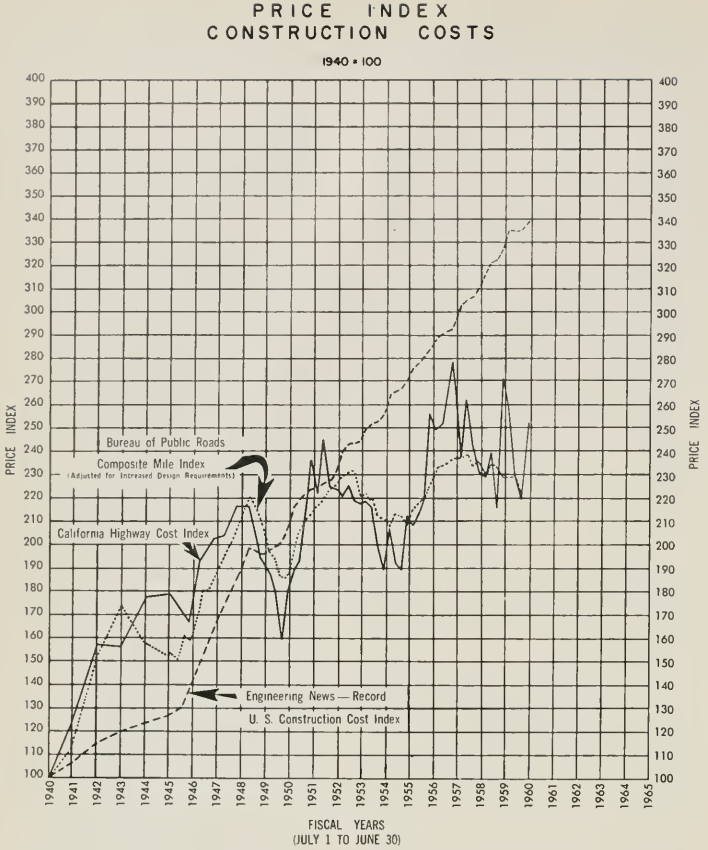
No. of contracts		Centerline miles
35	Portland cement concrete	145.0
85	Asphalt concrete	764.7
49	Asphaltic mixes (plant-mix and road-mix)	131.9
17	Seal coat	239.2
52	Traffic signals and lights	
43	Bridges	
154	Miscellaneous	
435	Total	1,280.8

NOT ON STATE HIGHWAY SYSTEM
County Roads—Federal Aid Secondary

No. of contracts		Centerline miles
17	Asphalt concrete	67.9
33	Asphaltic mixes (plant-mix and road-mix)	113.4
4	Seal coat	20.0
7	Grading	29.9
10	Bridges	
8	Miscellaneous	
79	Total	231.2

STATE PARKS, ETC.

No. of contracts		Centerline miles
1	Asphaltic mixes (plant-mix and road-mix)	0.3
2	Miscellaneous	
1	Grade	2.0
1	Bridge	
5	Total	2.3



Federal Aid

A total of $227,708,867 in federal aid funds was apportioned to California for 1960-61 under the Federal-Aid Highway Act of 1958. This included $17,451,261 for primary highways, $9,224,241 for secondary routes, $19,946,525 for urban routes, and $181,086,840 for interstate highways. The federal matching ratio on primary, secondary and urban projects is 58 percent. On interstate projects the federal ratio is 91.6 percent.

At the start of the fiscal year, construction was in progress on 78 contracts with a total cost of approximately $279,907,000, financed with federal-aid primary, urban and interstate funds in the amount of $217,704,000.

Sixty construction contracts involving $22,837,000 of primary funds, $18,794,000 or urban funds and $90,328,000 of interstate funds were completed during 1959-60. These amounts, together with the required state matching funds, bring the combined total cost of such improvements completed during the year to approximately $168,790,000.

Sixty-three contracts were awarded with a total cost of $208,154,000, involving primary, urban and interstate federal aid funds totaling approximately $161,801,000. Forty-five of these contracts provide for improvements on the national system of interstate highways with a total cost of $138,429,000 of which the federal share amounts to $122,974,000.

Right-of-way project agreements with the Bureau of Public Roads increased the total of interstate federal aid funds obligated for participation in right-of-way acquisition costs by $39,045,000 to a total of $230,389,000.

Industry Contact

The Industry Contact Section obtains prevailing wage contract data from contractor and labor organizations; collects information for the establishment of equipment rental rates; represents the division at hearings of the California Public Utilities Commission concerning dump truck rental and asphalt hauling rates; and processes minor contracts.

Prevailing Wages

Prevailing wage and fringe benefit information was furnished for all highway contracts advertised for bid, right-of-way clearance contracts, minor contracts, and service contracts for equipment rental and other services.

All wage and fringe benefit determinations were filed with the Director of the Department of Industrial Relations once each quarter.

Force Account Equipment Rental Rates

A large volume of information on construction equipment is being obtained from the industry. From analysis of these data, a more comprehensive schedule of the rental rates to be paid to contractors for equipment used on force account work will be established.

Minor Contracts

Small projects for which the cost will not exceed $5,000 are handled by the districts. Revised instructions covering the procedure for handling these minor contracts were published during the year.

A total of 329 minor contracts with a value of nearly $600,000 was awarded during the year. The average amount per contract was approximately $1,800.

Right-of-Way Clearance Contracts

As in past years, contracts were awarded for clearing rights-of-way in advance of construction, except where improvements were disposed of through sales.

For altering and moving buildings, relocating irrigation systems and fences, and drilling wells, 17 contracts involving a total cost of $445,000 were awarded.

Contracts for the demolition of buildings totaled 396 with a total cost of $700,000. On 15 of these jobs, the contractors paid the State $14,900 for salvage. Of the total of 413 right-of-way clearance contracts placed under way, 404 had been completed and nine were still active at the end of the year.

Ten informal bid contracts involving $144,000 were awarded during the fiscal year.

Service Contracts

Nearly 4,300 service contracts were processed, involving a total expenditure of $6,000,000.

This type of contract (formerly called service agreement) is used for renting equipment and obtaining certain required services. Its use is confined to work not covered by the State Contract Act and not adaptable to minor contracts, right-of-way clearance contracts or other prescribed procedures.

The principal use of service contracts, involving expenditure of nearly $1,600,000, was for the rental of equipment for highway maintenance, for highway construction by honor camps, and for occasional day labor highway construction projects.

Other uses were for utility services, maintenance and repair of state-owned buildings and grounds, repair to rental properties, maintenance and repair of office machines and engineering equipment, rental of office machines, and rental of field quarters.

STATE OF CALIFORNIA, DIVISION OF HIGHWAYS, STATE HIGHWAY MILEAGE [1]
BY SURFACE TYPES
(By North and South Counties, Inside and Outside Cities)
December 31, 1959

TYPE	NORTH			SOUTH			TOTALS		
	Outside cities	Inside cities	Total	Outside cities	Inside cities	Total	Outside cities	Inside cities	Grand total
Portland cement concrete	583.451	149.917	733.368	604.115	325.356	929.471	1,187.566	475.273	1,662.839
Asphalt concrete	150.267	140.782	291.049	135.914	178.515	314.429	286.181	319.297	605.478
Bituminous macadam	193.476	23.501	216.977	102.786	25.950	128.736	296.262	49.451	345.713
Plant mix gravel	3,055.410	282.616	3,338.026	2,175.157	358.409	2,533.566	5,230.567	641.025	5,871.592
Road mix gravel	829.599	12.938	842.537	1,541.303	26.632	1,567.935	2,370.902	39.570	2,410.472
Oiled gravel	1,201.366	25.029	1,226.395	152.019	2.416	154.435	1,353.385	27.445	1,380.830
Gravel	26.717		26.717				26.717		26.717
Oiled earth	720.061	2.213	722.274	781.823	5.168	786.991	1,501.884	7.381	1,509.265
Earth	39.949		39.949	23.162		23.162	63.111		63.111
Bridges	68.714	31.760	100.474	32.967	17.999	50.966	101.681	49.759	151.440
Ferries [2]	1.067	0.450	1.517				1.067	0.450	1.517
Unconstructed road	1,206.482	117.303	1,323.785	759.586	214.295	973.881	1,966.068	331.598	2,297.666
Totals	8,076.559	786.509	8,863.068	6,308.832	1,154.740	7,463.572	14,385.391	1,941.249	16,326.640
Totals—Constructed road	6,870.077	669.206	7,539.283	5,549.246	940.445	6,489.691	12,419.323	1,609.651	14,028.974

[1] Centerline mileage which does not include nonadd mileage such as frontage roads, connections, etc.
[2] Water portion, only.

The Federal-aid Secondary Roads Unit processes all matters pertaining to the FAS program, acting in liaison between the U.S. Bureau of Public Roads and the counties. The section also administers County Road System records, joint highway district projects, local flood relief projects, and the new program for urban extension of FAS routes.

The FAS Program

One-sixth of California's roads and streets are included in one of the Federal-aid Highway Systems. These are classified into three groups: Interstate, Primary and Secondary. The first two consist entirely of state highways. The third group includes both state highways and the most important local roads and streets.

Status of System

During the year, more than 1,000 miles of roads were added to the Federal-aid Secondary System in California. This increase was divided almost equally between state highways and county roads. Most of the state highway mileage consisted of forest highway routes.

For the past several years, the counties have been urged to formulate long-range FAS construction programs and to expand their FAS systems accordingly. Most of last year's additions to the County FAS System are the result of this advance planning.

The FAS System mileage total at the end of the year was 11,854, including 8,012 miles of county roads and 3,842 miles of state highways. The totals at the end of the previous year were county roads, 7,512 miles, and state highways, 3,319 miles.

During the year, 63 county federal-aid secondary contracts were awarded at a total cost of $17,131,683. These funds were expended on 2,720 miles of road and 399 bridges.

Federal funds for secondary highways, authorized for the 1960-61 fiscal year, were apportioned to the State by the Secretary of Commerce on October 8, 1959. After a deduction of $537,332 for repayable advances made under the previous year's "D" program, California received $9,224,241, of which $8,388,160 was reapportioned to the counties. The State retains 12½ percent of the total allocation for work on FAS state highways and for planning purposes.

California statutes also provide for allocation of up to $100,000 a year to each county for use in matching federal funds. A total of $4,254,200 in state highway funds was made available for this purpose. This enabled most of the counties to match their federal allocation entirely with state funds, on the basis of about 42 percent matching money to 58 percent FAS funds.

The Urban Extension Program

During the year, a new local highway aid program was started. The enabling act, Section 143.3 of the Streets and Highways Code, permits the State Highway Commission to allocate state highway funds to assist local agencies in financing work on FAS routes in urban areas.

Prior to enactment of this legislation, such streets and roads were somewhat orphaned financially. Federal law confined secondary funds expenditure to rural areas, but compelled extension of the secondary system into urban areas to achieve integration of the federal-aid network. On the other hand, federal-aid urban funds were retained under state law in the State Highway Fund, and hence are not available to the local agencies.

Projects to be financed under the urban extension program are proposed by the cities and counties with requests for fund allocations by the Highway Commission.

The commission will allocate funds for eligible projects, after local proposals have been reviewed and approved by the Division of Highways. The local agency is required to match allocations on a dollar-for-dollar basis. Appropriate design standards must be met, and no more than $500,000 will be allocated for projects in a city or county in any one fiscal year.

Actual construction may be handled by either the State or local agency, according to an agreement.

During the year, a total of $790,250 was allocated for urban extension projects in Alameda, Contra Costa and Los Angeles Counties and in the Cities of Long Beach, Pomona and West Covina.



This new Sisquac River Bridge near Garey in Santa Barbara County replaced an alder county structure which was damaged by flood waters. The new bridge was constructed out of county and state flood relief funds.

Storms of 1960

California's new "stand-by" flood relief law was used to aid local governments in 1960, the first year after its adoption. This Emergency Flood Relief Law was added to the State Government Code (Sections 54150 to 54164) by Chapter 1511, Statutes of 1959.

Patterned after the Flood Relief Law of 1956, the 1959 law establishes procedures to be followed in handling flood relief appropriations. In the past, separate laws have been required to deal with each flood, and this often resulted in an excessive time lag.

When the 1960 floods occurred in northwestern California, however, all that was required was the appropriation of relief funds by the Legislature (Section 12B, 1960 Budget Act).

Four counties filed applications for state assistance involving 109 separate locations of damage. Estimated cost of the projects eligible for state allocations was $1,953,150, requiring $1,362,667 in state funds and $590,483 to be paid by the local agency.

Flood Repairs

While the 1960 flood relief program was still in the preliminary stages, repair work continued on the widespread damage caused by the heavy storms during the spring of 1958. Although practically every part of the State was affected in 1958, individual items of damage were not so large as in the 1955-56 floods, which destroyed many vulnerable bridges. None of the replacement structures was damaged by the 1958 floods.

The Budget Act of 1958 provided $15,000,000 in state funds to help pay the cost of local repairs to public facilities. Federal funds for emergency repair were also made available as the result of the general disaster.

A total of 112 applications for aid were received. At the end of the year, 97 agreements with local agencies were in effect, and 39 cities and 28 counties were receiving assistance for nearly $12,500,000 in damage repairs at 1,500 locations. This involved expenditure of $6,865,210 in state funds, $1,545,275 in federal emergency relief funds, $42,759 in federal civil defense funds, and $3,445,426 in local funds for repair and $567,274 in local funds for betterment.



This four-lane expressway on Van Buren Boulevard, a Riverside County Road near Pedley, was completed in 1960 under the Federal Aid Secondary County Road Program.

Construction methods used in the 1958 flood program are similar to those developed for the 1956 work. Emergency repairs have been made by local agency forces or under emergency contracts let by local authorities. The remainder of the work has been completed or is being performed under full local control. However, restoration of federal-aid secondary roads is done under Department of Public Works contracts engineered substantially by local personnel.

Floods of 1955-1956

Most of the repairs authorized under the Flood Relief Law of 1956 have been completed. The remaining unfinished work consists of nine bridges in Humboldt County, which sustained the greatest damage, and two pedestrian bridges in the City of Santa Cruz. As of June 30, 1960, five of these bridges were under construction, plans were approved for two others and plans were being prepared for the remaining four. Considering the remoteness of much of the work, and the demands on local finances and personnel, the overall achievement by the cities and counties involved is commendable.

The combined program for repair and restoration after the 1955-56 storms and floods amounted to more than $21,000,000, distributed as follows: state funds, $13,928,873; federal emergency relief funds, $3,041,116; federal civil defense funds, $1,329,627; local funds for repairs, $1,368,975; local funds for betterment, $1,379,608.

County Maintained Roads

Annual certification of county maintained road mileage issued to the State Controller in accordance with Section 2121 of the Streets and Highways Code showed an increase of 344.88 miles to a new total of 69,422 miles. County Primary Road System changes, approved by the department in accordance with Section 2004 of the Streets and Highways Code, resulted in a net increase of 21.69 miles, bringing the total to 23,454 miles.

Although the net increases are nominal, there was considerable fluctuation of mileage due to annexations by cities on the one hand and acceptance by the counties of new subdivision streets on the other.

Joint Highway Districts

The single Joint Highway District still active during the fiscal year was JHD No. 9, covering the Cabrillo Highway, State Sign Route 1, between Santa Cruz and San Francisco. All the construction contemplated by the member counties, Santa Cruz, San Mateo and San Francisco, has been completed and a final report is being prepared.

CITY AND CO-OPERATIVE PROJECTS

The primary function of the City and Co-operative Projects Engineer is the administration of the gasoline tax funds allocated for use on city streets not on the State Highway System.

Allocation of Funds

Sections 194 and 2107 of the Streets and Highways Code require that five-eighths cent per gallon of the State's 6 cents per gallon gasoline tax is to be spent for city street purposes. These funds are apportioned on the basis of the population of each city.

As provided in Section 2107.5 an additional annual apportionment is made to each city for engineering and administrative expenses in respect to city streets. The law sets up a formula for the allocation of these funds on the basis of population varying from $1,000 annually for a city with a population of less than 5,000 to $20,000 annually for a city with a population greater than 500,000. A total of $1,165,000 was apportioned for engineering during the year.

This unit is responsible for the apportionment and payment of these two funds; for the preparation and execution of agreements providing for expenditure of these funds; for the review and approval of major city street systems; for the review and approval of plans and specifications for projects, and the granting of authority to advertise for bids and awards contracts or proceed with the work by day labor.

A total of $32,080,631.81 was apportioned from the ⅝-cent gas tax allocation for expenditure on city streets during the year. In addition, there was on hand an unexpended and unbudgeted amount of $9,021,612.48 and savings on completed projects of $8,001,033.59, making a total of $49,103,277.88 available for budgeting during the year.

Budgeted Funds

The amount budgeted for expenditure during the year from the ⅝-cent funds amounted to $37,877,854.73 leaving an unallocated, unexpended amount of $11,225,423.15 to be carried over and become available for budgeting in the fiscal year beginning July 1, 1960.



The ⅝-cent gas tax funds were used to finance a large scale improvement on Market Street (above) in southwest San Francisco. The major city street project involved realignment, widening and construction of bridges.

The amount budgeted for surveys and plans, right-of-way, and construction was $28,472,231.55, and for maintenance $9,405,623.18.

The total amount of gasoline tax provided for maintenance operation was less than the 40 percent of the annual allocation allowed by the law. A number of cities chose not to use gas tax funds for maintenance purposes, but rather to use all available gasoline tax funds for construction.

The funds budgeted for city street engineering and administration amounted to $1,418,088.08 for the year.

The 877 agreements, which were prepared and executed with incorporated cities, set forth all gas tax projects; the type of work to be performed, and the amounts authorized for each project. During the year, 453 sets of plans were reviewed and approved for construction.

Population Data

Since all funds apportioned to cities are based on population, it is important to keep city population figures up to date. The law provides that the population of inhabited territory annexed to city, or that of a newly incorporated city, shall be determined by multiplying by three the number of registered electors on the effective date of annexation or incorporation. Population of uninhabited areas is determined two years after the date of annexation, by the same formula.

Cities which have a large increase in population may apply to the U.S. Bureau of the Census for a special count. Special census figures must be used in all subsequent allocations of gasoline tax funds.

Under the law which became effective on July 1, 1959, cities may request the State Department of Finance to make an estimate of increased population. If this increase is 5 percent or more, subsequent allocations will be based on the estimate. Ninety-eight estimates on this basis increased the city population figures by 357,004.



Truxtun Avenue in Bakersfield was completed as a six-lane major city street in May, 1960, at a cost of $156,000 in ⅝-cent gas tax funds.

Eleven new cities were incorporated during the fiscal year as follows:

Date	*City*	*County*	*Estimated population*
July 15, 1959	Del Mar	San Diego	4,182
July 15, 1959	Half Moon Bay	San Mateo	2,262
Aug. 4, 1959	Rosemead	Los Angeles	19,602
Dec. 21, 1959	Grover City	San Luis Obispo	5,871
Dec. 28, 1959	Lawndale	Los Angeles	16,608
Jan. 20, 1960	Novato	Marin	14,505
Jan. 28, 1960	Commerce	Los Angeles	8,563
Mar. 1, 1960	Los Alamitos	Orange	3,000
Mar. 23, 1960	Mirada Hills	Los Angeles	24,975
May 25, 1960	Temple City	Los Angeles	37,758
May 31, 1960	Sand City	Monterey	360
Total			137,688

There were 1,128 annexations during the year, accounting for a population gain of 31,884.

Total population of the 366 incorporated cities at the end of the year was 11,214,747, or 71 percent of the estimated 15,830,000 total state population. This was an increase in urban population during the year of 555,503 or 5.2 percent.

These reported population changes are not fully representative of actual population changes. The Streets and Highways Code limited censuses for each city to two per decade after January 1, 1960, and stipulated that no estimates could be made between April 1, 1960, and the release of the 1960 federal census figures.

Major Street System

According to law, each city must establish a system of major city streets, subject to approval of the Division of Highways. The review and approval of these major city street systems, or changes therein, are made with great care to insure that gasoline tax funds will be spent to provide the greatest possible traffic benefits.

Master plans being developed by many cities and counties provide a definite basis for selection of the major city streets, and also provide a basis for continuity of design.

Co-operative Relationships

Liaison with cities is maintained through the 11 highway districts. Discussions are continually held with city officials. Manuals of instruction issued by the Division of Highways are distributed to city officials to keep them advised of the latest developments and methods on highway design, construction and maintenance.

Procurement

During 1959-1960, the Division of Highways purchased through its Service and Supply Department and the Purchasing Division of the Department of Finance $13,638,379.10 of commodities ranging from ordinary office supplies, printing, and specialized engineering equipment, to a wide range of maintenance and construction materials.

These purchases were made by means of 12,080 requisitions through the Purchasing Division at an average rate of 48 requisitions forwarded daily. Purchases for warehouse stock are included in the above figures. In addition, as in the previous year, a considerable number of surplus U.S. government items were obtained through the U.S. Bureau of Public Roads, ranging from canvas to photographic equipment.

The purchases do not include automotive equipment, which is handled by the Equipment Department.

Warehousing and Distributing

The Service and Supply Warehouses in Sacramento and Los Angeles filled 29,083 requisitions for a total of 95,404 items with a total value of $4,108,762.50. The value of warehouse stock on hand at the end of the year was $2,102,661.22. The average inventory for the fiscal year was $2,160,240.81, showing a stock turnover of 190 percent. A total of 95,404 items were shipped in 12,122 shipments as follows: freight, 5,417; P.P.S., 1,562; parcel post, 552; warehouse truck, 4,589; express, 2.

The catalogue of commodities available from the warehouses lists 4,863 items and is kept current for use of 440 offices which order equipment and supplies. In addition, 1,509 selected sections of the catalogue are distributed to engineers and technicians who do not need the complete catalogue.

Loans of Steel to Contractors

The steel strike in the winter of 1959 caused many contractors to request that steel be earmarked for them for jobs which would be ready to roll during the early months of 1960; but by the time most of the contracts were activated, the steel market had improved, making it unnecessary to secure the steel from the loan account.

Ninety-eight tons of I-beams previously loaned for temporary detour structures were still in place. Some 90 tons of I-beam were earmarked for jobs which were to be let after the close of the year.

District Stores

The inventory value of materials carried in district stores as of June 30, 1960, was $1,748,883.38. This is an increase of 8.5 percent over the previous year end inventory and represents principally an increase in stocks of signal, lighting, chemical and fencing items necessary for maintenance purposes.

Many items in district stores were used as state-furnished materials on minor contracts or, if obsolescent, disposed of by sale. It is one of the most important duties of the field co-ordinators to prevent the accumulation of unnecessary and undesirable items in this account, and to help promote the use of materials available without purchasing additional quantities.

Salvage and Utilization of Materials

Structurally and economically sound materials were salvaged from highway structures and other facilities which were removed during construction operations. These materials are used in new construction and maintenance of existing facilities.

Prior to salvage, materials are inspected by service and supply co-ordinators to decide their value and whether or not they should be salvaged. Only approved materials, for which a need is foreseen, are salvaged.

Heavy I-beams and timbers were furnished for a structural test bridge on the US 50 Freeway in Oakland. Two hundred tons of I-beams and lift machinery were salvaged from the Rio Vista Bridge for possible use on similar Sacramento River bridges.

Out-dated traffic signal equipment salvage has been very extensive this year, resulting in an increase of the value of the district stores account inventory in spite of the sale of approximately $500,000 to other political subdivisions or use on secondary locations.

Reproduction, Photography, Records Center

The Headquarters Reproduction Section reproduced 4,500,000 square feet of full-scale blueprints and 4,043,000 single sheet impressions of half-scale plans during the year. Production in the second half of the year was about twice that for the first six months. New equipment was installed to handle the workload increase.

The photography laboratory has continued to provide varied photographic services throughout the Division of Highways. Color prints have been widely used for bridge design purposes and as exhibits at various public meetings.

Approximately 15,000 cubic feet of records were in storage at the Records Center. Sixty-nine tons of records were sold as waste paper in conformance with retention schedules. The Los Angeles Records Center had capacity for 4,200 cubic feet, most of which was in use.

Costs of storage and operation at the Records Center is approximately 98 cents per cubic foot, whereas the accepted figure for filing storage in the office is approximately $20 per cubic foot. The difference represents a continuing savings to the division of $285,300 a year, not including the return from waste paper sales. A further savings difficult to determine results from not buying new file equipment.

Business Volume

Following is a tabulation of service and supply business for the fiscal year:

Direct purchases	$9,523,675.97*
Warehouse purchases	4,114,703.13
Warehouse disbursements	4,108,762.50
Inventory as of June 30, 1960:	
District stores	1,748,883.38†
Warehouse accounts	2,102,661.22
*Regular purchase orders	8,124,365.17
Subpurchase orders	1,399,310.80
	$9,523,675.97

† Does not include $73,376.01 in Headquarters radio supplies. (Departmental Communication Engineers—Highway Radio Shop.)

The preceding figures include purchases for 11 districts, Bridge, Bay Bridge, Materials and Research, and Headquarters Office exclusive of purchases for warehouse stock items.

Following is a resume of the allocation and disbursement of funds for acquisition of nonrental equipment during the 1959-1960 fiscal year:

Allocated	$1,116,000.00
Funds expended	874,210.10
Funds reverted	241,789.90

The nonrental inventory as of June 30, 1960, amounted to $11,981,252.83.

MANAGEMENT ANALYSIS

The Management Analysis Section studies management problems, provides advisory services, and assists in the establishment and maintenance of the records-management program.

An inventory of records and a review of procedures in the Headquarters Record Center was completed as a followup to the original program started in 1957. Recordkeeping schedules were updated. This resulted in moving even more office-held files to the records center and the destruction of additional records no longer required. Written procedures were developed for more efficient processing of material to and from the center.

An improved file classification system, with a written manual on procedure and organization, was adopted in District V as the result of a pilot study.

Staff representatives visited each of the districts to review requests for file equipment, to assist with filing problems, and to study records management practices.

A management survey of the Headquarters Equipment Department and four representative district shops was completed. Special attention was paid to shop administrative practices.



U.S. Highway 40 between San Francisco and Sacramento is rapidly being converted to full freeway standards with several large scale projects now budgeted or under construction. A new six-lane section on this route (above) was completed during the year in the vicinity of Davis.

PLANNING

The functions of advance planning, programs and budgets, design, traffic, photogrammetry, and highway planning survey are the responsibility of the Assistant State Highway Engineer, Planning.

ADVANCE PLANNING

In the past year the Advance Planning and Photogrammetric Sections were combined under the direction of the Principal Highway Engineer—Advance Planning.

The Advance Planning Section processes project reports, co-ordinates the steps involved in route adoptions and freeway declarations, processes freeway agreements, and works with local, state and federal agencies in planning state highways.

Project Reports

A project report is made after an engineering investigation and analysis of a specific project. The report sets forth the reasons for and nature of the highway improvement proposed, and the proposed manner of accomplishment.

Project reports are required for all proposed improvements. They constitute both a starting point and a control mechanism in planning and budgeting and provide information needed to establish basic design features. They are prepared in the districts.

The reports are reviewed at the Sacramento headquarters where analysis by the various departments is co-ordinated by the Advance Planning Section after field review. The analysis provides the basis for orderly development of surveys and plans.

Aerial mapping continues to be an increasingly valuable tool in the evaluation of topographic controls and in expediting the preparation of project reports.

Approximately 280 project reports were processed during the year.

Freeway Routes

The development of an integrated system of freeways, one of the most important phases of modern highway planning, has been emphasized in California for many years. It involves consideration of community values and potential land uses, as well as traffic needs and benefits.

According to long-established policy of the California Highway Commission, local authorities are advised when freeway route studies are started by the Division of Highways and also kept informed of general features of proposed freeway units prior to route adoption action by the commission.

During the year, 47 formal public meetings were held by the district staffs to discuss state highway routes. There were also many conferences with city and county officials and their technical staffs, as well as several hundred public meetings and map displays of the informational type.

The results of conferences, together with transcripts of public meetings, are made available to the Highway Commission for consideration in route deliberations. The commission itself held seven public hearings during the year, five at the request of local authorities and two on its own initiative.

The mileage of declared freeways was increased by approximately 309 miles during the year through commission action. On June 30, 1959, the total declared freeway mileage was 5,203. The mileage added during the year represented 43 units, 31 of which involved a major route relocation.

Freeway Agreements

The co-operation achieved with cities and counties in working out and concluding freeway agreements has been extremely satisfactory. Agreements for 150 freeway units were received for processing during the year. In some cases, original agreements were replaced by supplemental agreements which incorporated improved design standards or provided for changes in traffic patterns or local planning.

Other Studies

Many proposals, suggestions, resolutions, and inquiries regarding routes, plans and financing were received from official agencies, private organizations and individuals.

Investigation, correspondence, and preparation of reports and replies occupied a great deal of time and frequently required the compilation and careful analysis of statistical and engineering data.

One such study resulted from a request from the Legislative Committee on Transportation and Public Utilities for a report bringing up to date the inventory of needs on the State Highway System.

In connection with this study, it has been the responsibility of the Advance Planning Section to obtain statewide uniformity and adequacy in the design factors, including pavement structure and the proper spacing of interchanges, to be used in the estimate.

Interstate Highway System

A new statewide interstate highway deficiency study was in progress during the year. In connection with this study, the Advance Planning Section was responsible for obtaining prior approval from the U.S. Bureau of Public Roads on such factors as the route locations and basic design features including the number of traffic lanes, median and right-of-way widths, and the location of separation structures, interchanges and frontage roads.

Advance planning is also responsible for obtaining bureau approval on the final locations of all routes on the Interstate Highway System. This is done for each Interstate Section after adoption by the California Highway Commission. At the end of the year, the locations for approximately 1,682 miles, about 77 percent of the Interstate System in California, had been approved. In addition, another 396 miles were being processed for submission to the bureau. The total mileage approved or under consideration at the end of the fiscal year is about

95 percent of the Interstate System in the State.

Liaison With Other Agencies

In addition to work with local jurisdictions, advance planning involves co-operation with other governmental agencies in planning matters involving state highways.

The effect of proposed public works on existing and planned highways is carefully studied. In some cases a planned project will require a relocation or adjustment of a state highway. At such times, the Advance Planning Section negotiates an agreement with the agency involved, establishing the standards for replacement of the highway or other changes. Provision for highway betterments are frequently included in these negotiations at the division's request.

National Forest Highways

The Division of Highways acts jointly with the U. S. Bureau of Public Roads and the U. S. Forest Service in an annual improvement program on California roads designated as Forest Highway Routes. The Forest Highway network in California covers approximately 2,465 miles, about 80 percent of which is on state highway routes.

The California apportionment of Forest Highway funds for the 1959-60 fiscal years was $4,726,004. Including funds remaining from previous apportionments, the distribution of Forest Highway money in the State during the year was as follows: projects on state highways, $3,320,000; projects on county roads, $1,375,000; system surveys, $200,000.

The Bureau of Public Roads plans, designs, advertises and supervises the construction of federally financed Forest Highway projects. On projects on state highways, the Division of Highways works with the bureau in the planning and design phases and also purchases the required rights of way, including clearance of utilities and options on material sites.

Photogrammetric Map Aerial Photography and Contracting

The continued use of aerial photography for advance planning accounts for an average of 15 percent of photogrammetric costs. Current photography is a primary aid in the planning of photogrammetric mapping projects.

Where new highway projects require a different alignment, grade change or extensive widening, nearly all projects are designed from photogrammetric mapping. Photogrammetric mapping is obtained under contract by means of stereoplotting instruments and field surveys as required.

Following is the resume of expenditures for photogrammetric contracting during the fiscal year:

	Contracts	*Highway strip miles*	*Contract amount*
Contour mapping projects for design	33	298	$360,607
Contour mapping projects for reconnaissance	8	69	31,948
Aerial photography contracts	17		38,416
Aerial photography contracts (blanket)	6		73,042
Stereoplotter rental contracts	8		14,990
Total			$519,003

Map Checking

A continuing program of map checking has proven to be an invaluable aid in obtaining accurate photogrammetric mapping by contract.



This section of the Golden State Freeway (upper left to lower right) was completed early in 1960, providing a major interchange at the junction with the San Bernardino Freeway near the Los Angeles County Hospital.

An estimated 320 highway miles of mapping were scanned during the year. The scanning procedure gives an overall picture of a project and isolates the areas that require further field checking. It also eliminates the need for extensive field checking.

Resultant savings in overall checking costs is estimated to be over $20,000 for the year.

Geodetic Distance Measurement

During the fiscal year, the Photogrammetric Section operated instruments for accurate geodetic distance measurement as a service to all the state highway districts.

A Model 3 Geodimeter, measuring distances up to 20 miles, was used to establish a control network for photogrammetric mapping, construction staking and right of way surveys. In March 1960, a Model 4 Geodimeter was obtained for use in measuring shorter distances.

Estimated savings by geodimeter surveys over conventional methods amount to $60,000 for the fiscal year.

Observation data for surveys with the two geodimeter models is as follows (Model 3 figure listed first): Observed miles 964, and 300; number of lines, 297, and 448; average line length, 3.24 miles, and 0.67 mile; estimated highway miles, 550, and 200.

PROGRAMS AND BUDGETS

The Programs and Budgets Section makes projections on the availability of funds for highway purposes, establishes target figures to be used in planning, develops the statewide long range planning program in co-operation with Planning Survey, prepares budget recommendations for consideration by the California Highway Commission, maintains a constant check on the funds available for highway purposes in a fiscal year budget, recommends action on unbudgeted or minor improvement projects, and administers the annual Buildings and Plants Program.

Budget and Revenue

The responsibility for preparing the annual budget for consideration by the California Highway Commission rests with the Assistant State Highway Engineer, Planning. Engineering control of the State highway budget is performed under the supervision of the Office Engineer.

The revenues which support the activities of the Division of Highways are derived from state and federal sources. State sources, which still comprise the major portion of the revenue, are the gasoline tax, the use fuel tax, motor vehicle fees, and the transportation tax. Federal apportionments for right of way acquisition and construction under way on federal-aid projects during the fiscal year amounted to approximately $302,000,000 or about 48 percent of the total revenue.

The division's revenues closely accord with the volume and type of highway traffic. Long-established and continuous records of this traffic throughout the State are used as a guide in estimating probable revenues for planning purposes. For budgeting, estimates of probable revenues are determined after consultation with other governmental departments and agencies with functions related to State highway income, particularly the Department of Finance, and Motor Vehicles, and the Board of Equalization.

During the 1959-60 fiscal year, the state highway budget was adjusted periodically to conform to current requirements as well as to reconcile differences between estimated and actual revenues and expenditures.



Recently completed six-lane freeway on U.S. Highway 40 in Richmond which eliminated final gap in continuous full freeway between Las Gatos and Valleja.

Expediting and Co-ordinating

The establishment of the expediting and co-ordinating function has resulted in a close liaison between the districts and headquarters departments. Frequent reviews of the status of the various proposed construction projects helped to eliminate delays in completion of plans, right of way acquisition or utility relocations.

Statistical records are being maintained to show the complete status of a highway construction project from initial planning studies to the call for bids.

Buildings and Plants

During the fiscal year progress was made on the construction of annex buildings at the district offices in Los Angeles, Redding, San Bernardino and San Diego. Plans were being developed by the Division of Architecture for annex buildings in San Francisco and at headquarters office in Sacramento, as well as for several maintenance stations.



Ventura Freeway in the San Fernando Valley section of Los Angeles, a portion of 90 miles of continuous full freeway on US 101 between the west city limit of Los Angeles and south of San Clemente in Orange County. Interchange in center connects freeway with Ventura Boulevard, the former highway route.

In the 1959-60 fiscal year, the number of individual projects for which contract plans were processed dropped to 355 from the record peak of 414 for the preceding fiscal year. Despite this decrease, the growing emphasis on freeway improvements, and the complexities of freeway design, brought a further increase in the work load.

Geometric Design

The Geometric Design Unit processed 544 interchange and grade intersection designs, 422 bridge site plans and the contract plans for 355 projects. With the increasing emphasis on freeway construction, the complexity of plans has increased. This is reflected in the augmented volume of plans reviewed—5,600 plan sheets in 1959-60 compared to 3,700 the previous year.

A master plan for weigh scale installations on the State Highway System was established in collaboration with the Maintenance Department and the California Highway Patrol. Revised design standards were developed for yard installations and for enlarged brake and certification inspection facilities.

Revised design controls for bus stops at interchange areas on freeways were developed. A number of these facilities were constructed during the past year.

Structural Design

Structural typical cross sections representing 147 proposed projects were reviewed during the design stage. This review included consideration of costs, the availability of materials, materials specifications, foundation and slope design, construction practices and future maintenance requirements.

Since the Structural Unit review provides one of the final opportunities for headquarters inspection of district proposals prior to submission of plans, the scope of this review has been expanded. This procedure has resulted in early elimination or solution of many problems formerly encountered during the final stage of project design. At the same time, the review of all preliminary reports, materials reports and special provisions continues to be a function of this section.

Studies were continued on the actual service performance of various modified structural designs in order to provide factual data for the evaluation of current standards and policies. Features under observation include thickened asphalt concrete pavement sections, variable joint arrangements in PCC pavement, subsurface drainage, and cut slope and benching details.

Representatives of the Structural Design Unit participated with personnel from other headquarters departments in continuing studies relating to foundation stabilization, embankment protection, slope design and drainage.

Special projects included participation in the development of standard specifications and standard special provisions and in estimates for completion of the Interstate Highway System and the state highway inventory.

Electronic Computations and Special Studies

An improved method for submitting terrain notes for computing earthwork quantities with the electronic computer was introduced. This method consists of using a print of spot elevations along the centerline. Its greatest advantage is that it facilitates key punching. When contour maps are used instead, the elevations and offset distances are recorded directly on strips of transparent paper or film printed with a grid. The notes are written in when the grid transparency is overlaid on the contour map.

The section on Surveys for the Planning Manual of Instructions was written and reviewed in Headquarters. It is scheduled to be submitted to the districts for comments before publication.

Drainage and Co-operative Agreements

With the increase in freeway construction, drainage problems have become more complex. In urban areas long sections of depressed freeway are more frequently required, and this has meant increases in the use of multiple pumping installations.

Where urban freeway construction will necessitate modifications in existing drainage facilities or street patterns, the changes have been successfully arranged through co-operative projects of mutual benefit to the State and the local community. This approach has also led to economies through the proper timing of local projects in relation to highway construction. In such instances, the division helped pay the cost of changes or betterments which could be incorporated in the future highway improvement.

During the fiscal year, 91 agreements of all types were executed with various agencies. These covered drainage improvements, separation structures, intersection revisions and modifications of street patterns, and construction of future utility crossings.

Erosion Control and Roadside Development

Because of their specialized nature, plans for functional planting and landscaping projects continue to be prepared in the Headquarters Roadside Development Unit. During the fiscal year, plans and specifications for 29 such projects were completed. Specifications for erosion control work to be included in construction projects are prepared in the various districts and are reviewed by this unit.

All typical cross sections for proposed projects are referred to this unit for recommendation as to erosion control or preparatory planting items which should be included in the construction contract. It is generally more economical to include in the construction contract certain types of erosion control and such preparatory planting items as deep scarification, spreading topsoil, and installing water lines under roadways.

During the fiscal year, 40 functional planting or landscape projects valued at $3,980,000 were financed.

Following is a partial list of the items and quantities used on these functional planting and landscape projects: 3,675 tons straw, 147,203 pounds seed, 954 tons commercial fertilizer, 362,255 assorted trees and shrubs, and 9,865,680 assorted ground cover plants and cuttings.

Traffic Counts and Accident Studies

In 1959, motor vehicle travel on the State Highway System, urban and rural, exceeded 30 billion vehicle miles, an increase of approximately 5 percent over 1958.

Motor vehicle travel on rural state highways, based on the annual and monthly traffic counts, was estimated to be 17.5 billion vehicle miles in 1959, a slight increase over 1958. The increase would have been greater if a number of high volume "rural" highways in suburban areas had not been reclassified as "urban."

Traffic on the 746 miles of rural and urban full freeways in operation during 1959 averaged 36,000 vehicles per day. Highest volumes were recorded on the Hollywood and Harbor Freeways in Los Angeles. The average weekday traffic on the section of the Hollywood Freeway just west of the four-level structure was 204,000 vehicles, while the section of the Harbor Freeway immediately south of the four-level structure carried 202,000 vehicles per day. The four-level structure in Los Angeles, the world's busiest intersection, carries a weekday volume of approximately 352,000 vehicles.

The 1959 fatality rate on rural State highways, was 7.78 deaths per 100 million vehicle miles of travel. This is a slight decrease from last year's rate of 7.86, and marks the lowest fatality rate ever recorded on rural state highways in California.

The 1959 fatality rate on freeways, rural and urban combined, remained unchanged from 1958 at 2.83 deaths per 100 million vehicle miles of travel.

Geometric Standards and Traffic Service

A study on the operation of freeway bus loading facilities at cloverleaf interchanges was completed during the past fiscal year.

In conjunction with the Planning Survey Section, new techniques for forecasting traffic in metropolitan



This experimental electro-luminescent overhead sign is being tested on U.S. Highway 99E just northeast of Sacramento. New equipment of this type is tried to determine its suitability for highway use under actual operating conditions.



This large overhead sign is typical of those now in use on new freeways throughout the State. Note the "up arrow" to direct movements off the freeway.



New speed limit signs were installed near state boundaries to inform motorists of maximum limits on California highways. This sign is on U.S. Highway 40 near the Nevada border.

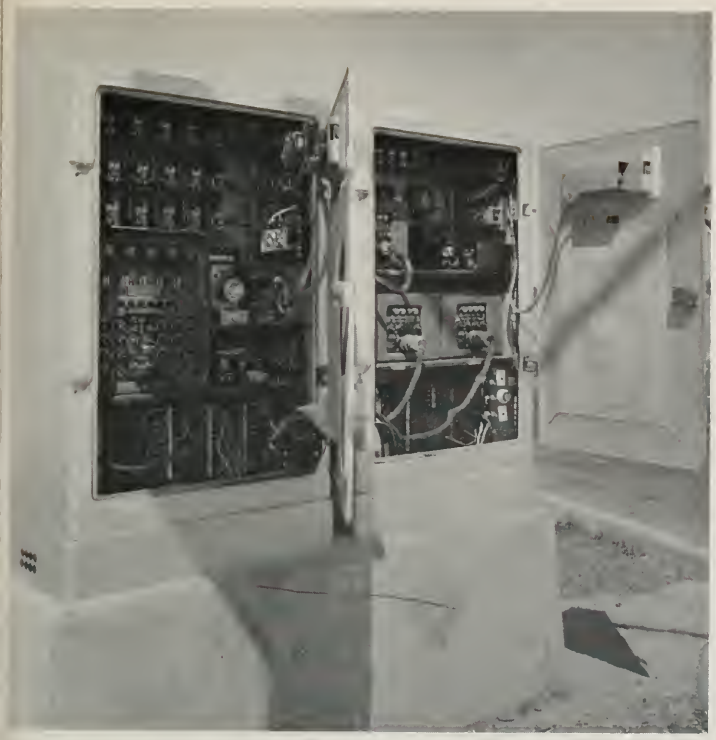
areas were developed and investigated. This included methods of obtaining travel data from land use characteristics, trip distribution by use of traffic models developed from origin and destination studies, and the determination of trip paths between areas by use of electronic computers.

Origin and destination surveys were made at eight locations during the year.

Traffic Signals and Illumination

During the 1959-60 fiscal year, there were 90 new traffic signal installations, and 85 existing signal systems were modernized. Of the new installations, 72 were the traffic-actuated type and 18 were of the pretimed type. A total of 3,556 lighting standards and 384 illuminated traffic guide signs were installed. The total cost of the electrical work was $5,651,505, not including the cost of steel sign structures.

A total of 169 traffic reports reviewing conditions at approximately



Traffic signal control units of this type are used to control multi-phase signals at many rural intersections.

321 intersections were analyzed to determine the need for the installation of traffic signals or safety lighting.

Research projects under way included studies of a new-type electroluminescent highway directional sign and two new types of vehicle detectors.

A new internally illuminated changeable message sign was developed, primarily for use at truck-weighing stations.

Traffic Regulation and Control

The 1959 Legislature enacted a law establishing an absolute maximum speed limit of 65 miles per hour on all streets and highways in California. The new statute includes the provision for downward speed zoning in five-mile increments between 60 and 25 miles per hour on the basis of an engineering and traffic study. Other changes involve elimination of mandatory speed zones on state highways, in business and residential districts, and a statement of legislative intent that physical conditions such as width, curvature, grade and surface conditions, or other conditions readily apparent to the driver, would not require special downward zoning.

Traffic studies were conducted throughout the State to determine those sections of highway where, due to roadside development and traffic conflict, a 65-mile-per-hour limit was not considered to be reasonable and safe. As a result of these studies, a total of 620 restricted speed zone orders were issued, resulting in 761 additional miles of restricted speed zoning on state highways. Existing speed limits were also revised on considerable mileage. A total of 3,307 new speed limit signs were installed at a cost of about $84,000 as a result of the new speed limit provisions.

After investigation and study, the following traffic-control measures were taken: 113 city and county ordinances or resolutions regulating traffic or parking were approved; 44 orders regulating traffic and parking were issued; and a total of 40,409 new highway signs were approved and installed, including 4,346 warning signs, 8,782 regulatory signs, 12,675 guide signs, and 14,606 construction and miscellaneous signs.

During the year, a new edition of the Planning Manual, "Traffic," was published. This revision included legislative changes enacted by the 1959 Legislature, and the latest methods and policies pertaining to traffic engineering. The manual was distributed to city and county highway and traffic officials in an effort to promote greater uniformity in the use of traffic-control devices throughout the State.

A new edition of the "School Crossing Protection" pamphlet was published on January 1, 1960, and distributed to school superintendents and other interested officials. A new edition of the "Uniform Sign Chart" was also published.

Much time and effort have been spent in preparation and review of a tentative illustrated text for the new "Manual on Uniform Traffic Control Devices for Streets and Highways" to be published by the U.S. Bureau of Public Roads.

A study, made with the co-operation of the Materials and Research Department, involved the testing of delineator spacings on various radius curve. This study resulted in the adoption, nationally, of a new formula for spacing of delineators on horizontal curves.

Other studies undertaken during the year included several concerned with further development of standards for interstate highway signs. One of these studies involved the development of a standard green color for use on illuminated guide signs, and another dealt with night time readability of various reflective signs in order to determine the effectiveness and proper size and stroke of letters. Standard rules for placement of interstate shields, when used in combination with other shields, were set forth.

The Planning Survey Department is divided into two main operating units, Collateral Engineering and Statistical —Financial. Engineering and economic investigations assigned to the Highway Planning Survey usually cover more than one district or are statewide in nature. Many such studies are undertaken at the request of the U.S. Bureau of Public Roads. Most studies are financed partly by federal funds amounting to a maximum 1½ percent of the total annual federal-aid apportionment to California.

Within the Statistical Unit there is an Electronic Data Processing and Machine Methodology Section which provides data processing services for Planning Survey and other departments, as well as for other divisions of the Department of Public Works.

The Planning Library is also attached to Planning Survey.

Collateral Engineering Studies

The 1959 Legislature adopted Senate Concurrent Resolution 62 requesting an analysis and updating of city street and county road deficiency reports along with estimates of future needs. The resolution also requested a report on the advisability of an increase in the gasoline tax and on the relative distribution of any such additional tax to cities and counties. The report was to be submitted to the appropriate legislative committees by August 1960.

The Legislature appointed a committee of 14 members representing the cities, counties, and others interested in transportation problems, to act in an advisory capacity to the Department of Public Works. The committee held monthly meetings with the staff during the period of the study, and individual committee members also participated in field area meetings. The advice and assistance of the committee proved invaluable in conducting the study.

County road and city street deficiency reports prepared under the provisions of Section 2156 of the Streets and Highways Code were found inadequate for the purpose of the S.C.R. 62 study. It was considered necessary that the cities and counties prepare new reports.

The advisory committee, meeting jointly with the department, developed the methodology, controls, and procedures necessary to initiate the study. The committee decided that the deficiencies evaluated must be valid, practical projects that would be done; that the cities and counties should lay out integrated systems classified as major or primary routes, collector routes, existing local streets, and future local streets; that the estimated deficiencies be based on traffic requirements to 1980; that the deficient projects be phased into five-year periods to 1980; and that the city and county reports be submitted by May 1, 1960.

Standards, forms and instructions in use under Section 2156 were reviewed and modified by the advisory committee. On October 5, 1959, the final standards, forms and instructions were forwarded to the cities and counties through the district offices.

To promote uniformity, area meetings were held throughout the State by the highway district personnel assigned to the study. The meetings were attended by the engineers and officials who would be preparing the city and county deficiency reports, representatives from the Division's Sacramento headquarters, from the U.S. Bureau of Public Roads, and members of the advisory committee.

Purpose of the study was explained at these sessions and the need for uniform application of engineering judgment in evaluating valid deficiencies was emphasized. Local officials were informed that district personnel would be available to furnish technical assistance.

Close co-operation between the districts and the cities and counties was necessary because of the short time limit and to permit analysis and review of the work as it progressed. The study covered approximately 70,000 miles of county roads and 30,000 miles of city streets.

City and county reports, along with the district's comments, were received during May 1960 and reviewed for uniformity on a statewide basis. The audited amounts in the reports were tabulated and text and tables prepared for the department's report. The copy for the report was submitted to the printer on July 1, 1960.

Throughout the study, city and county interest and co-operation was excellent, and both state and local agencies benefited through greater understanding of each other's problems.

Interstate System Estimate

Federal law requires a revised estimate of the total cost to complete the Interstate Highway System in each of the states, with the objective of establishing factors for apportionment of Interstate funds for the fiscal years 1963 through 1966. The completed estimate was to be submitted to the United States Bureau of Public Roads, Washington, D.C., by August 1, 1960.

The Engineering Unit of Highway Planning Survey was assigned the responsibility for overall co-ordination of the work on the Interstate System estimate in co-operation with the U.S. Bureau of Public Roads. The work covers all of the 2,183 miles of Interstate routes in California and includes project cost estimates on all sections not completed to standards required for estimated 1975 traffic.

Preliminary work on developing traffic data and strip maps was started in January 1960. Copies of the manual of instructions were received in February. At the end of the fiscal year, work had progressed through the traffic estimate, geometric planning, interchange and lane justification, and cost estimates of right-of-way and construction.

The work was being done in close co-operation with the B. P. R. Traffic estimates, maps, locations, geometric design, right-of-way, and construction costs were prepared by District personnel in each of the eight districts involved in the Interstate program. The Headquarters, Bridge, Design, and Right of Way Departments also handled various phases of the project.

This estimate, known as the 104(b)5 estimate, supersedes the estimate prepared in 1957 which was known as

the 108(d) Interstate estimate. The manual of instructions covering this latest estimate requires much more checking and documentation than was required for any previous estimate.

State Highway Inventory

In accordance with a request by the Senate Fact Finding Committee on Transportation and Public Utilities, an inventory of needs on the State Highway System was prepared for submission to the committee by September 15, 1960.

State highway needs were last reported in 1958 in connection with Senate Concurrent Resolution No. 26. The Legislature, in acting on the S. C. R. 26 report, passed Senate Bill 480 which added approximately 1,600 miles to the State Highway System and established the California Freeway-Expressway System. The committee considered it advisable to update the 1958 state highway needs inventory to conform with a similar inventory for city streets and county roads requested in S. C. R. 62.

The detailed work in preparing the estimate was assigned to the various departments in the districts with final review by Planning Survey. The interstate estimate, prepared for submission to the Bureau of Public Roads, will be incorporated in this state highway inventory.

Planning Survey also prepared data for submission to the Bureau of Public Roads to support an application for additional mileage to be added to the Federal Aid Primary System in California.

Statistical Studies

The Division of Highways is participating in the long-term Los Angeles Regional Transportation Study. The areas included in the study are Ventura, Los Angeles, and Orange Counties, and the western regions of San Bernardino and Riverside Counties.

The purpose of the study is to establish travel patterns for use in determining the present and future transportation needs of the five-county area. These patterns will be derived from data on present and projected land use, population, employment, motor vehicle registration, and other economic and social factors affecting travel.

The magnitude and complexity of this study require the close co-opera-



Members of the technical advisory committee of city and county officials who assisted in the preparation of the S.C.R. 62 Report on county road and city street deficiencies. The report was presented to the Legislature in September, 1960.

tion of local and state governments. In recognition of the importance of the problems of co-operation among the various governmental units, and also to provide general guidance for the technical staff, an advisory committee was established. The 12-man committee is made up of officials from county traffic, planning and engineering departments, and representatives from an automobile club and transit and traffic research groups.

In addition to this committee, an advisory planning group, composed of all planning directors in the five counties and representatives of the various cities, was also established. This group will assist in obtaining the detailed information on land use.

The Automotive Safety Foundation will provide technical advice particularly in connection with the development of land use and trip distribution models. This agency has taken part in similar programs in major cities throughout the nation.

The study will be conducted by District VII of the Division of Highways, with the responsibility for data processing and study methodology assigned to Planning Survey.

In addition to the establishment of a working organization and general planning for land use and traffic distribution models, the initial phases of the study have also included two major data collection projects. These projects were both initiated in June 1960. They are a Home Interview Origin and Destination Survey for about 3,000 dwellings, and a Special Survey for about 2,500 "For Hire Trucks."

Fuel Consumption Study

A special fuel consumption study, based on records kept by personnel of the Division of Highways, has been undertaken at the request of the Bureau of Public Roads. About one-fifth of the division's employees are keeping records of gasoline purchased and miles driven in their private vehicles for a one-month period. One-quarter of this sample will keep records in each of four different months during the year.

Electronic Computer Service

The Electronic Computer Review Committee was organized late in 1958 to guide the development of applications and use of electronic computers for engineering problems. The committee is composed of representatives from the construction, design, planning, bridge, and planning survey departments.

Programs and applications developed by other states are obtained and studied. Suggestions and ideas for new programs or changes in existing programs are reviewed. Evaluation of benefits, costs of development, and priorities are considered by the committee before making recommendations.

The committee also keeps departments informed of new ideas and developments before programing is started, and co-ordinates development so as to obtain programs of maximum utility.

The District Engineers have been encouraged to appoint co-ordinators to expedite processing of engineering calculations. The Planning Survey staff assists and trains these district co-ordinators and others when they visit the machine room in Sacramento.

Electronic computer service has grown considerably and was used to process approximately 1,500,000 traverse courses, 3,600 miles of earthwork quantity data, and 122,000 profile grade and superelevation hinge points during the year.

A refined earthwork computation program was completed and testing was undertaken in two districts. This program will automatically detect cut or fill conditions at cross section hinge points and then automatically apply stake slope calculation data.

The revised traverse computation program, released in the prior year, has been used extensively. It allows rotation of bearings, curve alignment calculations, output of descriptive data, interdependency within the same traverse problem and between traverse and curve alignment problems, and also interdependency regardless of the number of possible solutions.

A profile grade and grid program also introduced last year, has been well received by the districts. This program combines profile grid data, superelevation data, and template data to compute roadbed template elevations.

Due to the need for more flexible and more complicated computation services, at reasonable time schedules, additional tabulating equipment and computer facilities have been authorized.

Other Studies and Services

The annual loadometer survey and a special rural origin and destination survey on U.S. Highway 50 near Tracy were completed during the year.

The mechanical routing program for freeway studies, under development in the previous year, was completed. The first practical use of this program has been undertaken in connection with study of traffic data for Sacramento.

A special analysis was completed during the year in conjunction with the Materials and Research Department for methods of acceptance sampling of reflector buttons used in signs from private manufacturers.

Other statistical and data processing work was performed for the Accounting, Personnel, Construction, Bridge, and Traffic Departments.

Financial Analysis

Three continuing studies have been carried on in co-operation with the Bureau of Public Roads: local road finance reports, highway investment and road life studies, and the status of highways with related mileage reports.

The local road finance report is an annual report of the highway transactions of local units of government. It is one of a series of annual reports required by the bureau.

The continuing road life study covers some 12,000 miles of rural state highways with new construction added annually. Tabulations of mileage and investment are prepared as requested.

The status of highways provides logs of the State Highway System and the Federal Aid System and various tabulations of mileage for the bureau and the division.

BRIDGES

The Bridge Department of the Division of Highways is under the administration of the Assistant State Highway Engineer—Bridges and is responsible for the design, construction and maintenance of all bridges and structures on the State Highway System. As provided by law, the department also assists other state agencies and local governments upon request.

A branch office of the Bridge Department is located in Los Angeles to maintain liaison with southern area districts, make preliminary site surveys, and supervise construction and maintenance of structures within these districts. All other functions, including all design work, are handled in the Headquarters Office in Sacramento.

For purposes of administration, the Bridge Department is divided into five sections. These are planning, operations, special studies, office, and special projects. The maintenance and operation of State-owned toll bridges are also under the administration of the Assistant State Highway Engineer —Bridges.

The 1959-60 state highway construction budget included $105,642,000 worth of structure work in 104 projects, a 50 percent increase over the preceding year. Most of this was new construction, although some was for widening or strengthening existing structures. Miscellaneous projects including flood damage repair, federal aid secondary projects, maintenance, and work for other agencies financed and contracted during the 1959-60 fiscal year amounted to $25,020,000 for a grand total of $130,662,000.

Manual of Design Practice

Over the years the Bridge Department has prepared individual papers on the design of different types of structures as a means of training employees. These individual chapters have now been compiled into a 633-page textbook. This text, the "Manual of Bridge Design Practice," was copyrighted, and printed by the State Printing Office.

At the end of the year, approximately 60 Bridge Department employees were participating in the two-year inservice training rotation program, and 39 men had completed the program, which first started in 1957.

BRIDGE PLANNING

Advance Planning

The Advance Planning Section has the primary responsibility of expediting all phases of bridge planning. Eighty-eight district project reports and 85 supplemental project reports were reviewed, and 420 bridge preliminary reports were prepared.

Plans, specifications and estimates for approximately 90 percent of the 1960-61 bridge construction program were completed by June 30, the end of the preceding fiscal year, and for some $34,000,000 worth of work remaining from the 1959-60 Budget.

Design

Plans, specifications and estimates were completed during the past fiscal year for structures estimated to cost approximately $113,667,000. This includes regularly budgeted state highway projects; Federal Aid Secondary System projects; structures in flood damage, paint, repair, and miscellaneous projects; and unfinanced projects prepared for future state highway budgets.

The largest single project was the San Pedro-Terminal Island Suspension Bridge, estimated to cost $13,760,000. The bridge will be 6,010 feet long, including the suspension span over the main channel of Los Angeles Harbor. The suspended span will be 1,500 feet long, providing minimum clearance of 185 feet at mean high water for a 500-



This structure across the South Fork of the Eel River on US 101 (Redwood Highway) in Humboldt County was among bridges judged most beautiful in national competition sponsored by the American Institute of Steel Construction.

foot central navigating channel and 165 feet minimum clearance at the towers. The 368-foot towers will be flanked by two 506-foot side spans. The remainder of the bridge will be made up of steel girder approach spans. The 52-foot roadway will provide for four traffic lanes. When completed the bridge will be operated as a toll bridge.

An interesting bridge design is the Sign Route 24 separation on the recently completed Walnut Creek Bypass. This structure is 1,220 feet long with a 37-foot roadway which carries two lanes of traffic over another roadway and over the Walnut Creek Channel. Physical limitations required long spans and shallow depth which could only be met with continuous prestressed concrete. The continuous spans are 160, 214, 160 feet, the longest prestressed spans so far designed by the Bridge Department.

Plans were completed for the remaining $12,000,000 unit of the $31,000,000 Santa Monica Freeway Viaduct between the Los Angeles River and Hoover Street. An unusual feature of this job is the type of foundations used. Bridge foundations consist of a large reinforced concrete footing, founded on piles or soil with columns extending up to the bridge superstructure. Because of the favorable soil conditions at this site, it was possible to eliminate the footing and to merely drill an extension of the column into the ground. It is estimated that this type of foundation resulted in a saving in excess of $3,000,000. (See Foundation Section.)

In Alameda County plans were completed for the new parallel Caldecott Tunnel (formerly Broadway



Sign Route 24 seporotion structure on the recently completed Walnut Creek Bypass. This groceful structure has the longest continuous prestressed concrete spans thus for designed by the Bridge Department.

Tunnel) located approximately 100 feet north of the present tunnel. The new tunnel, in conjunction with the existing, will provide for four lanes in one direction and two lanes in the opposite direction during hours of peak traffic. The new bore will be approximately 3,300 feet long with a roadway width of 28 feet. It will be fully lighted and ventilated. Estimated cost is approximately $12,000,000.

Plans were also completed for the bridge across South Fork Eel River on the Redwood Highway (US 101) at Myers Flat, Humboldt County. Estimated to cost $1,000,000, the structure will have four spans, two side spans 175 feet long and two 235-foot center spans.

Architectural Bridge Design

Along with its primary function of reviewing all bridge engineering designs for aesthetic qualities, the Bridge Architectural Design Section produced 47 architectural renderings, 41 photo retouches and 9 models. These were used not only for design purposes, but also for district public meetings, press releases, exhibits and legal proceedings.

An aerial oblique photo retouch of a proposed freeway and interchange in Riverside County was accepted as an exhibit in a superior court trial. The retouch was used to help explain freeway drainage plans to a jury. This is the first photo retouch made by this section for legal purposes.

A model of the proposed US 101, US 395 and State Sign Route 94 Interchange in San Diego was constructed to help the designers visualize and unify the architecture of the 36 structures to be built within a one-half square mile. Four-level and three-level structures were included. The model will also be used in explaining interchange features to San Diego residents and other interested citizens and as an aid during construction and later landscaping.

Two California entries received awards in the annual American Institute of Steel Construction judging of beautiful bridges. The prize winning structures are the South Fork Eel River Bridge on US 101 at Dyerville and the Marsh Road Overcrossing on the Bayshore Freeway (US 101 Bypass) in San Mateo County.

Foundation Section

The Foundation Section has had an interesting project involving the evaluation of load test data from 48 inches cast-in-drilled-hole piles installed in granular sediments on the Santa Monica Viaduct in Los Angeles.

The test loads were applied by jacking against two reaction piles and a reinforced concrete beam engineered for this purpose. (See photos on page 54.)

Twice the design load, or a total of 900 tons, was applied to the pile for a period of 60 hours by a battery of 100-ton hydraulic jacks operated from a central hand-operated pumping unit.

The pile settlement was measured by Ames dials and leveling beams reading to a thousandth of an inch. The permanent settlement recorded at the completion of the test was just under one-half inch.

The results of these tests indicate that the calculated theoretical load carrying capacities of these piles in granular sediments closely approximate the actual test load.

No new equipment was purchased during the year, but improvements were made on old equipment in an effort to make it safer or more efficient. One such improvement was the installation of safety holders for casing driving hammers on all drilling machines, permitting easier handling with less hazard to personnel.

Normal drilling operations included foundation exploration for more than 400 bridge structures and a total of 23,691 feet of retaining walls.

Bridge Construction Costs

Bridge construction costs, as measured by the Bridge Department Index (base year 1939-40 = 100), began the year with an index value of 260 and moved successively to quarterly values of 262, 253, 237, and 245. The period was characterized by especially keen competition among contractors and by a 6 percent reduction in the level of construction costs.

BRIDGE OPERATIONS

Sixty-seven bridge contracts were completed during the year at an approximate total cost of $34,262,000, which includes $8,842,000 in road work. In the same period approximately $37,342,000 worth of structure work was completed in 68 district contracts for an overall total of $71,604,000 on 135 projects involving more than 397 individual structures. This compares with 440 structures constructed in the preceding year. The reductions resulted from uncertainty about federal financing during a part of 1959. At the end of the fiscal year, 121 bridge construction contracts in progress amounted to $158,264,000, including projects financed from various fiscal year budgets and work being performed on Federal Aid Secondary Projects and for other state agencies. This also includes funds for the Benicia-Martinez Bridge and the West Branch Feather River Bridge.

Construction was started on the combination highway and railroad bridge across the West Branch Feather River. This two-deck structure is a part of the relocation of US 40 Alternate and the Western Pacific Railroad around the proposed Oroville Dam and Reservoir. The bridge will have four main truss spans, with a combined length of 1,820 feet and of highway approach spans 911 feet long, for a total length of 2,731 feet. A four-lane highway will be carried on the top deck and a single-track railroad on the lower deck.

Metropolitan Area Freeway Structures

In San Francisco construction was completed on the Route 2 68 Separation, part of a major interchange at the junction of the James Lick Memorial (Bayshore) Freeway and Alemany Boulevard (Southern Freeway). Final construction cost was approximately $6,200,000. The interchange facilitates traffic movements between the freeways and is designed to provide for future extension of the



The Bridge Department tested the load carrying capacities of cast-in-drilled-hole piles on the Santa Monica Freeway in Los Angeles. A specially engineered concrete beam (above) was used in the test.



Test holes were applied by jacking against reactian piles and the concrete beam.



A total load of 900 tons was applied to the pile by a battery of 100-ton hydraulic jacks (above) operated from a central pumping unit.

Southern Freeway to the east. The bridge work consisted of constructing four bridges, widening a bridge and extending two pedestrian undercrossings. The main interchange structures are of reinforced concrete box girder construction, except one 115-foot suspended span which is precast, prestressed concrete girders, supported on box girder cantilevers. The precast members were built so as to simulate box girder construction for aesthetics.

The Walnut Creek Bypass Freeway was completed, involving construction of 16 structures at a cost of $3,357,000. This facility takes Sign Route 21 (Interstate 680) around the congested city streets of Walnut Creek, connecting it with Sign Route 24 to the west by means of a major three-level direct interchange.

At the end of the year, work was nearly completed on four structures, included in the project providing the final US 40 freeway link through El Cerrito and Richmond.

Construction was well under way on the first two units of the MacArthur Freeway (US 50) in Oakland with a call for bids issued for the third unit. Approximate construction cost of the nine structures in the first two units is $4,245,000. Estimated cost of the 14 structures in the third unit is over $2,000,000.

In Los Angeles, the Santa Monica Freeway, the Los Angeles River Bridge and Overhead and the interchange at the Harbor Freeway were completed, and two contracts comprising 2.3 miles of the Santa Monica Viaduct, linking the Harbor Freeway with the Santa Ana-Golden State-Pomona Freeways, were under construction. Thirty-one structures were included in projects completed on the Ventura Freeway through the San Fernando Valley.

The Mulholland Drive Overcrossing, spanning the future San Diego Freeway, was completed. This is a curved soffit box-girder with a center span of 235 feet, the longest of this type ever built in the West.

In the San Bernardino-Riverside area, completion of six interchange structures on the San Bernardino Freeway between Ontario and Colton

marked completion of construction necessary to convert this highway from expressway to full freeway standards, between Los Angeles and San Bernardino.

Late in the year, work was started on the four-level structure interchange which will be the hub of the San Diego Freeway system.

Webster Street Tube

Work started on the Webster Street Tube under the Oakland Inner Harbor between Oakland and Alameda. The contract cost is $16,641,000, the largest contract ever awarded for California highway work. Right-of-way costs exceed $3,000,000 and supplemental railroad work is estimated at $180,000. The total cost of the entire project will exceed $20,000,000.

The new tube parallels the present Posey Tube, which is one block to the east. After the Webster Street Tube is opened to traffic in the fall of 1962, the old and the new tubes will operate as a divided highway with each carrying two lanes of one-way traffic. All controls will be located in the Oakland Portal Building of the Posey Tube.

The new tube will have ceramic tile ceilings and walls down to the roadway level and two lines of continuous fluorescent light. The roadway will be 24 feet wide with a sidewalk on one side for pedestrians and tube personnel. The portal to portal length of the structure will be 3,350 feet. The minimum structure depth will be 40 feet below mean lower low water under the 700-foot wide Oakland Inner Harbor ship channel.

The tube itself will be made up of 12 precast segments, 37 feet in diameter and 200 feet long, with one cast-in-place section 783 feet long. The precast segments will be fabricated in a graving dock constructed by the contractor, launched, floated to the site, and lowered into position in a predredged trench.

Federal Aid Secondary Bridges

The Bridge Department assists, and advises the counties in all matters pertaining to bridges on county roads included in the Federal Aid Secondary System.



Recently completed interchange at the junction of the James Lick (Bayshore) Memorial Freeway and the Southern Freeway in San Francisco. Stub-ends on structures will connect with future easterly extension of Southern Freeway.

During the fiscal year, 12 bridge contracts were awarded for the construction of 12 bridges and one highway separation structure at a total contract cost of over $2,300,000. There were also 13 major structures, costing $600,000, in 10 road contracts. This construction in 20 different counties was under the general supervision of state personnel. County engineering staffs designed and prepared plans for 15 of these projects and furnished the construction engineering for 19 projects.

Under the provisions of the Flood Relief Law of 1956 and the Budget Act of 1958, plans were reviewed and approved for the repair or reconstruction of flood-damaged county bridges having a total estimated construction cost of more than $1,000,000. County personnel designed and supervised construction of all these county contracts with state advice and assistance as required.

Bridge Maintenance

Bridge maintenance involves keeping the 6,518 bridges on the State Highway System in a safe and serviceable condition. Periodic field investigations are made; plans are pre-

pared for needed repairs and minor improvements; capacity ratings are reviewed and kept up-to-date; and replacements of structurally critical bridges are scheduled as necessary.

Bridge maintenance work and repairs, not including painting, cost about $450,000 during the year. Additional minor improvements, together with major repairs financed from construction funds, cost $150,000.

A flash flood on August 17, 1959, washed out four spans of a timber bridge across Crestview Wash on U.S. Highway 66 west of Needles. The approach roadway fills were also damaged at 12 other bridges in the area. Traffic was routed over a local county road until a short detour could be constructed around the Crestview Wash Bridge, and the approach fills restored at the other bridges. The four spans at Crestview Wash were replaced under contract.

A fire destroyed a two-span, timber bridge across Coral Wash on U.S. Highway 99 adjacent to the Salton Sea. A local detour was constructed by maintenance forces and the damaged structure was later replaced with a concrete bridge built under contract.

Flood waters of Hayfork Creek washed out an abutment of a bridge on State Sign Route 36 at Wildwood in Trinity County, causing the collapse of a 30-foot end span. The damaged span was removed and replaced with one of temporary construction. A new abutment and a permanent span will be constructed under contract.

Engineering investigations were made as required by law and at the request of the local authorities to determine safe load capacities on 99 city and county bridges. Ten public hearings were held in connection with the posting of weight limits on 15 of these bridges.

New construction made possible the dropping from the posted bridge list of two structures with load postings and four bridges with speed postings. On June 30, 1960, there were six structures on state highways posted for reduced loads and 38 for reduced speeds.



This bridge will carry Mullholland Drive over the future San Diego Freeway through the Santa Monica Mountains in Los Angeles. The earth embankment below the bridge will be removed to make way for the freeway.



A new bridge over the Yuba River on US 99E at Marysville was completed earlier this year. This aerial photograph shows the structure while construction was still in progress. Note old bridge (right) being removed.

The accompanying list of bridges shows all structures on the State Highway System, including the San Francisco Bay Bridge and the Carquinez Bridge, but excluding the Richmond-San Rafael Bridge. Structures having assorted types and lengths of spans are shown by number and length on the basis of the main span, but areas have been segregated and appear under the various type headings. Areas of bridges are based upon the clear width of roadway between curbs plus the clear sidewalk width.

Bridge Maintenance Painting

Six maintenance painting contracts were awarded involving 13 structural steel bridges. Total allotment for these contracts was $212,292. Painting was completed on 67 new bridges with over 2¾ million square feet of surface area.

Co-operative studies on experimental paint coatings by the Bridge Department and the Materials and Research Laboratory resulted in several revisions in standard paint formulations. Laboratory and field tests are continuing in an effort to gain information toward further prolonging paint system service-life.

A notable change in color of steel bridge finishing coat paint was made this year. Henceforth, steel bridges on state highways will be finished in new green colors, except for those in desert areas and some railroad bridges. Two new formulas were developed, one for the moist coastal atmosphere and one for the drier interior sections of the State. Nine bridges were being painted with the new colors in 1960.

Painting inspectors made about 700 inspections of bridge paint condition during the winter season. These inspections covered approximately 68 percent of the 1,021 state highway bridges which contain steel members.

Special Studies

The Special Studies Section provides engineering service on problems not included in established procedure for bridge production. Studies of a continuing nature are conducted in co-operation with interested and regulatory agencies. Topographic and hydrographic maps are filed and maintained for general usage, including determination of drainage areas and channel slopes for estimating flood flows. A library of engineering data is maintained.

Both independent and co-operative studies were conducted in the fields of hydrology, hydraulics, drainage, bridge pier scour, and bank protection. Technical information for legal actions was provided for the Division of Contracts and Rights-of-Way.

Technical papers were prepared on the riding qualities of bridge approaches and freeways in the Los Angeles area and on rules of law and terminology applicable in highway drainage matters.

Representatives of the Bridge Department serve on special committees studying such problems as land subsidence in the San Joaquin Valley and landslides at Pacific Palisades.

The Task Force Committee for the Palisades Landslide Study, which includes representatives from the Cities of Los Angeles, and Santa Monica

BRIDGES ON THE STATE HIGHWAY SYSTEM SEGREGATED AS TO NUMBER, LENGTH AND AREA BY STRUCTURE TYPE

(As of June 30, 1960)

Structure type	Number		Length (feet)	Area (square feet)
	1960	1959	1960	1960
Concrete Arch	242	248	40,001	901,322
Concrete girder	1,649	1,549	334,267	19,148,076
Concrete slab	2,234	2,185	134,402	5,523,707
Masonry arch	33	32	962	21,735
Subtotal concrete and masonry	4,158	4,014	509,632	25,594,840
Steel arch	5	5	1,708	26,760
Steel plate girder	322	279	171,150	5,698,357
Steel stringer	287	294	62,846	3,676,025
Steel deck truss	29	29	23,610	1,181,869
Steel pony truss	34	38	11,039	181,254
Steel through truss	69	70	116,965	1,512,874
Suspension	2	2	15,097	884,145
CMP multiplate & arch	65	63	1,330	45,094
Subtotal steel	813	780	403,745	13,206,378
Timber arch	3	3	859	6,352
Timber stringer	669	676	48,314	2,320,269
Timber deck truss	10	11	2,753	34,869
Timber pony truss	3	3	376	5,802
Timber through truss	1	1	79	1,722
Subtotal timber	686	694	52,381	2,369,014
Total bridges	5,657	5,488	965,758 (183 miles)	41,170,232 (945 acres)
Underpasses	185	182		
Overheads*	215	201		
Combined bridge & overheads*	42	38		
State highway separations*	214	196		
Road undercrossings*	738	660		
Road overcrossings	561	487		
Pedestrian undercrossings*	158	151		
Pedestrian overcrossings	67	64		
Cattlepasses*	92	74		
Tunnels	20	21	14,199	
Retaining walls	6	7	4,707	
Miscellaneous	22	20	1,909	20,266
Total structures	6,518	6,269	986,573	41,190,498
Drainage pumping plants	178	171		
Railroad grade crossings	720	755		

* Separations so noted are listed under structure type above.
NOTES: One underpass, 17 overheads, 1 tunnel, and 1 bridge and overhead also serve as State highways separation.

and Los Angeles County, submitted a comprehensive report to the Legislature in January 1960. Recommendations were based on information obtained in a series of field tests and in research on past slides.

Culvert and Hydrological Studies

Several continuing studies are in progress including a culvert pipe cost study based on contract prices; observation to test criteria used for design of reinforced concrete pipe; and research and analysis on bridge scour and culvert design.

A statistical method for depicting culvert distortion, employing the use of ogives, was useful in evaluating recorded data.

Hydrological studies to determine design recommendations for flow in channels and to provide a basis for estimating flow from areas to be drained by culverts on the future Westside Freeway in San Joaquin Valley were continued.

Studies of existing underpass drainage facilities have been made for the purpose of relating the pumping capacity and storage volume to flow entering the underpass.

BRIDGE OFFICE ENGINEERING

Bridge Office Engineering includes the administration and management of the various service units in the Bridge Department such as accounting, personnel, supply, equipment, files, mail handling and distribution, and maintenance and preparation of various records and reports.

A major function is the negotiation and preparation of maintenance and construction agreements with railroads in connection with construction of railroad grade crossings and grade separations.

Railroad Grade Separations

Forty-eight contracts involving railroad structures were awarded during the year, including 45 grade separation structures, two widenings, and one sidewalk addition.

Railroads contributed to the construction costs on nine of the separation structure projects, either in lump sum or on a percentage basis. A private business firm and a city also shared in the cost of structures. The Department of Water Resources is financing the West Branch Feather River Bridge, a highway-railroad structure.

Local Roads and Streets

The Public Utilities Commission issued a 1959-60 priority list containing 19 proposed separation structure projects to eliminate railroad grade crossings on county roads and city streets. According to state law, $5,000,000 in state highway funds is set aside by the Highway Commission each year to pay half of the cost of such separation projects, after deducting the railroad contribution.

As of June 30, 1960, allocations in the amount of $4,990,788.85 had been made by the Highway Commission from the 1959-60 fiscal year funds for seven of the 19 projects on the PUC list.

During the fiscal year, six applications were made to the State Reclamation Board for reconstruction of existing structures and construction of new structures.

SPECIAL PROJECTS

Carquinez Bridge

All phases of the construction work on the Carquinez Bridge have now been completed. The new parallel bridge was opened to traffic November 25, 1958. The widened and improved old structure, with new approach connections, was opened April 29, 1959.

Traffic on the Carquinez Bridge has exceeded preconstruction estimates made by bonding consultants. If this rate continues, it will be possible to pay off the bonds before the originally scheduled 1982 retirement date.

During its first year of operation as a toll facility, 11,907,018 vehicles used the parallel bridges, an increase of 15.5 percent over the previous year's traffic on the old bridge. Traffic counts were also up during the first part of 1960.

Benicia-Martinez Bridge

On July 22 and 23, 1959, bids were received for the substructure and the superstructure contracts for the main bridge between Benicia and Martinez.

This 6,215-foot structure will consist of a series of deck trusses and approach span girders. The deck trusses are from 330 to 528 feet long and the approach girder spans vary in length from 90 to 197 feet.

The roadway will provide for four traffic lanes with a 10-foot painted division strip down the center which can be used for emergency parking. Vertical clearance to be provided at the navigation channel is 138 feet above mean sea level. This is the same clearance as provided by the adjacent railroad lift bridge in its raised position.

By June 30, 1960, the construction progress on the bridge was considered satisfactory in view of the fact that both contracts had been delayed for more than three months due to the steel strike in the summer of 1959. The bridge is scheduled to be opened in July or August 1962.

At the end of the year, the foundation work included construction of the approach span piers and work to various stages of completion on four of the water piers.

Nine of the water piers are being constructed by precasting the cellular concrete footing blocks 44 feet wide by 86 feet long and 25 feet deep on shore, floating them into place and while anchored in position lowering six-foot diameter steel caissons through openings in the footing. The caissons are sunk into bedrock, which in most cases is about 120 feet below the water surface, by a huge rotary drill and

an air lift pump. Once the caissons have been drilled into bedrocks, they are filled with concrete, after which the load of the footing block is transferred to the caissons. After completing the concrete anchorage of the footing block to the caissons and placing the reinforced concrete top slab, the footing is ready for the start of construction of the pier shaft. The reinforced concrete pier shafts vary in height from 70 to 120 feet and are constructed by the slip form method.

This method of constructing deep water piers by floating the box footing into place and sinking large concrete filled steel caissons through them represents a revolutionary and progressive change over previous methods. It should prove economical and time-saving on future bridge construction projects where appropriate foundation conditions exist.

San Pedro–Terminal Island Bridge

The 1959 Legislature provided for the financing of the San Pedro-Terminal Island Bridge and highway facility. The funds will be from revenue bonds, state highway funds, and gas tax money available to the City and the County of Los Angeles. The bonds will be retired, and other funds repaid, through toll collections.

One small contract had been awarded in connection with the project at the end of the fiscal year. This job involved grading for relocation of a short section of railroad track.

Four other contracts were to follow for construction of the bridge substructure, the superstructure, the toll plaza and approach roadways, and for the installation of toll collection equipment.

STATE-OWNED TOLL BRIDGES— OPERATION AND MAINTENANCE

San Francisco-Oakland Bay Bridge

A record total of 38,440,097 vehicles crossed the San Francisco-Oakland Bay Bridge during the year. This is a gain of 3.29 percent over the previous year. The daily average for the year was 105,315.

The month of highest average daily traffic was June 1960, with a new high record of 110,411 vehicles per day. The previous high was in June 1959, when the daily average was 107,386 vehicles. A new single-day traffic record was established on September 4, 1959, with a total of 126,865 vehicles for the day. The preceding high was 123,488 vehicles on June 19, 1959.

The revenue derived from vehicular tolls, rent, interest, and miscellaneous services was $13,041,644.41. This was an increase of $652,094.34 over the revenue of the previous year.

In accordance with the action by the Toll Bridge Authority new truck tolls went into effect on May 1, 1960. Truck tolls were changed from a gross weight to an axle basis, with tolls established in multiples of 25 cents for all trucks. In each axle group, this change resulted in increases in tolls for some trucks and decreases for others, with an overall result of a small drop in revenue. This should soon be offset by normal increases in traffic.

Adoption of the axle-count method of assessing truck tolls resulted in greatly improved service to commercial haulers and eliminated the long lines of trucks which were frequently waiting at the toll plaza under the weight basis of toll assessment.

Improvements to Bridge Facilities

The remodeling of the Transbay Transit Terminal to convert it from train to bus operation was continued by the Division of San Francisco Bay Toll Crossings. Work also proceeded on revising the connecting ramps at the San Francisco end of the bridge and the south side of the Oakland approach. Train tracks were removed and replaced with precast concrete deck sections between San Francisco and the west end of Yerba Buena Island. One lane of new construction



New bridge now under construction over West Branch Feather River north of Oroville. The cambination highway-railroad bridge is being built as part of the relocation of U.S. Highway 40 Alternate around the reservoir to be farmed by the future Oroville Dam.

on the lower deck was opened to traffic on May 17, 1960, so that at the end of the year there were two lanes in use in each direction on the lower deck between San Francisco and the island.

Bridge Maintenance

As in previous years, this item consisted primarily of painting. At the end of the year, the bridge painting crew consisted of two foremen, six leadmen, 60 painters, two laborers, and four highway equipment operator-laborers. Painting operations had to be temporarily suspended at various locations at times to avoid conflict with the remodeling program.

Two new truss web scaffolds, for use on the 288-foot spans east of Pier E11, were purchased and installed.

Construction of a lower-deck traveler in the 288-foot spans from Pier E11 to Pier E23 was completed. This work consisted of installing two rails, each 3,500 feet long, below the lower deck and providing a traveling scaffold which is suspended from the rails.

Workmen erected the steel rails, a section at a time, from walkways cantilevered out from the traveler itself. As each new section of rails was bolted in place, the traveler moved out on it, placing the cantilevered walkways in position to erect the next section. Thus, the traveler moved out over open water like a giant spider, leaving a freshly spun web of steel rails behind it.

The traveler provides the painters with a 19- by 73-foot platform for use as a scaffold. The extremities of the traveler are cantilevered wings that can be folded back to allow it to pass the bridge piers. When the wings are extended, the painters can reach the widest parts of the bridge.

The traveler is driven by a pair of trolleys powered with compressed air supplied by a compressor on the Oakland shore and delivered by a pipeline running along the lower deck of the bridge.

The new rails contain 141 tons of structural steel and form a portion of a trackwork system which will, when completed, run under the entire length of the upper and lower deck roadways.

Only 6,000 feet of the 41,000-foot system remain to be constructed. A total of six traveling scaffolds have been added by the Division of Highways since the bridge was completed. These scaffolds greatly reduce the number of man-hours a paint crew would spend rigging conventional hanging scaffolds. They also provide a much safer work area for the men.

Just before the end of the fiscal year, work was begun at the West Bay paint yard, improving the facilities and constructing a new concrete building. This work is being done under a contract by the Division of Architecture. Planning was also begun on improvements at the toll plaza warehouse, with the objective of moving the East Bay paint crew headquarters from 34th and Wood Streets, Oakland, to the toll plaza location.

The total amount expended on general paint maintenance for the Bay Bridge was $720,360.17.

Emergency Roadside Service

The emergency fleet for roadside service consists of five tow trucks, four special bridge service pickup trucks operated in periods of peak traffic, and a fire truck. The continued increase in traffic volume, plus the increased number of automobiles diverted to the lower deck to relieve congestion on the upper deck, required a high level of emergency roadside service.

Toll Collection

Two different types of automatic toll collection machines were used on a trial basis for most of the year. The experiment indicated that permanent use of the machines was not advisable. The equipment did not increase lane capacity. Some additional traffic hazards resulted, due to last-second lane changes by persons who did not have the right change. The machines could not handle passes and commute tickets. For reasons such as these, the machines were removed in May 1960.

San Mateo–Hayward and Dumbarton Bridges

The total traffic on the San Mateo-Hayward Bridge for the year was 3,653,761 vehicles, and the toll revenue amounted to $1,426,821.05. For the same period, the traffic on the Dumbarton Bridge was 2,109,059 vehicles, with a corresponding toll revenue of $868,801.70. These figures, compared to those of the preceding fiscal year, indicate an increase in traffic of 274,207 vehicles on the San Mateo-Hayward Bridge and an increase of 338,071 vehicles on the Dumbarton Bridge.

No changes in toll rates were made during the fiscal year.

The lift span operation was continued on both bridges as required by federal law. During the year there were 1,875 lifts of the San Mateo-Hayward Bridge and 954 lifts of the Dumbarton Bridge.

Improvements to Bridge Facilities

The Division of San Francisco Bay Toll Crossings started construction operations which will ultimately result in expanding the traffic capacity of the San Mateo-Hayward Bridge. The extent of this work to date consists of dredging an access channel and depositing fill material at the west end of the bridge.

New electronic toll registration equipment was installed at the San Mateo-Hayward Bridge toll plaza.

Construction of embankments at the new Dumbarton Bridge toll plaza site was completed in June. This was the first of two projects required to complete the toll plaza, which is due to be finished in late 1961. A temporary toll plaza was also completed in June. This facility provides for two lanes in the most heavily-traveled direction during peak periods and materially reduces traffic congestion.

Rehabilitation

The program of structure rehabilitation provided for through the bond resolution was completed August 31, 1959. The cost of this work, plus the cost of minor rehabilitation work on the bridge approaches, amounted to about $3,300,000. The unused balance of about $200,000 in the Rehabilitation Fund was made available for partial financing of improvements of the Dumbarton Bridge approach roads. As of the end of the fiscal year, plans



Construction is continuing on the new Carquinez Strait toll bridge between Benicia and Martinez. This photograph, taken in April, shows the nearly completed concrete approach piers on the Martinez side. The large floating derrick in the water is used to set steel caissons in place.

had been completed for this work and the job was ready for advertising.

Maintenance

Maintenance costs of the San Mateo-Hayward and Dumbarton Bridges were paid from the State Highway Fund, in accordance with state law and the bond resolution. The principal maintenance item, painting, was continued throughout the year on the Dumbarton Bridge.

Construction of two timber pile dolphins at the navigable channel of the San Mateo-Hayward Bridge was completed in December, 1959. This work was necessary to provide immediate protection for the bridge substructure, after the easterly fender structure was demolished when struck by a ship. These dolphins were designed as an integral part of the fender reconstruction, which was completed in March. A claim was filed against the responsible party for reimbursement of the repair costs incurred.

Richmond–San Rafael Bridge

The number of vehicles which crossed the Richmond-San Rafael



Photo-sketch of the future San Pedro-Terminal Island Bridge over the main channel of Los Angeles Harbor. Plans call for the bridge to be financed partly by Toll Bridge Authority revenue bonds.

Bridge during the year was 3,218,713, and revenue was $2,750,853.50. These figures represent increases of 9.53 percent and 9.14 percent, respectively, over the preceding year.

At the end of the fiscal year, the toll collection staff consisted of one toll lieutenant, four toll sergeants, and 19 toll collectors.

Bridge Maintenance

The principal item in this category was the preventive paint maintenance program. The paint crew consisted of two structural steel painter foremen, two leadmen, and an average of 26 painters and two laborers. Electrical installations were maintained by a crew of four men, and roadway maintenance and roadway service was provided by five highway equipment operator-laborers under the supervision of a highway leadingman.

A contract to restore pier backfill material to the planned constructed limits was completed during February, 1960. Principal work was on Pier 30, a four-bell pier. Three other piers received rock backfill to bring the protective blanket to the desired elevations. This work cost $17,006.55.

The radio transmitter and aerial were moved from the Richmond Maintenance Building to a hill adjacent to the toll plaza. This move will afford better directional cover of the entire bridge for radio transmission and receiver reception.

Twenty-five thousand descriptive folders with a map of principal destination points in the area were obtained to enable toll collectors to issue them to patrons asking directions. This courtesy should help eliminate delays.

Carquinez Bridges

A total of 12,321,713 vehicles used the Carquinez Bridges during the year and a total of $4,346,641.75 was collected.

By action of the California Toll Bridge Authority, the toll schedule was amended, effective May 1, 1960, to extend the commutation book privilege to all Class 1 vehicles including certain types of pickup trucks. At the end of the fiscal year, the toll collection staff consisted of one toll captain, two toll lieutenants, four toll sergeants, and 40 toll collectors.

Bridge Maintenance

The major maintenance consisted of cleaning and painting the west bridge. During the year additional rigging equipment was obtained which permitted more efficient use of manpower by providing easier access to the bridge. At the end of the fiscal year the paint crew consisted of one structural steel painter foreman, a leadman, 14 painters, and a laborer.

Miscellaneous maintenance to the bridge, buildings, and toll facilities was performed by the roadway maintenance and roadside service organization. This organization also provided emergency road service to the traveling public within the toll crossing limits and maintained a fog and navigation watch to make sure that the warning and safety devices were functioning properly. This organization consisted of four highway equipment operator-laborers and a laborer, under the supervision of a highway leadingman.



The Huasna River Bridge on Sign Route 166 some 10 miles northeast of Santa Maria received first prize in Class II which includes bridges with fixed spans costing more than $500,000.



The Truckee River Bridge on US 40 13 miles northeast of Truckee received an honorable mention award in Class III which includes bridges with fixed spans costing less than $500,000.

Prize Winners

Four State-designed Bridges Receive A.I.S.C. Awards

Four California bridges, all designed by the State Division of Highways, have been chosen as among the 15 most beautiful bridges opened to traffic in 1959 in the annual Aesthetic Prize Bridge Competition sponsored by the American Institute of Steel Construction, national association representing the fabricated structural steel industry.

A fifth California bridge, designed by a private engineering firm for the Port of Long Beach, was also among the prize winners.

The Huasna River Bridge on Route 166, 10 miles northeast of Santa Maria, was chosen top award winner for Class II, bridges with fixed spans under 400 feet and costing more than $500,000.

The bridge "exemplifies a simple, direct statement of structure and design," according to the judges. "Here the designer utilizes simple form to obtain an overall pleasing effect." The judges also commented favorably on the rail design that is an integral part of the deck.

The Truckee River Bridge, 13 miles northeast of Truckee, was chosen for honorable mention in Class II, for bridges with spans under 400 feet costing under $500,000. "This is a straight-forward expression," said the judges. "Its simplicity is at home in its surroundings. The structural pattern does not offend the landscape."

The Kern Avenue Pedestrian Overcrossing, MacFarland, was also chosen for honorable mention in Class III. The judges praised the structural elements that "provide a pleasant rhythm with the landscape."

The Grant Line Canal Bridge was the only honorable mention in Class IV, movable bridges. The judges said it showed "an expressive use of material."



ABOVE—Another Class III honorable mention award winner is the Kern Avenue Pedestrian Overcarssing across US 99 at McFarland. BELOW—The Grant Line Canal Bridge won an honorable mention award in the movable bridges class. It is located between Stockton and Tracy on Federal Aid Secondary Highway 907 (Tracy Road).



PERSONNEL AND PUBLIC INFORMATION

The functions of personnel, training and safety, and public information are grouped administratively under the direction of the Engineer in Charge of Personnel and Public Information. Activities in these fields for the 1959-60 fiscal year are covered in the following section.

PERSONNEL

Personnel Management

During this year, position classification studies resulted in the establishment of 12 new civil service classes, and in the modification of specifications for 17 job classes.

Five new classes were established in connection with the increased use of electronic data processing programs. New supervisory classes were established for better organization in the photographic section and the outdoor advertising inspection unit.

The study of the use of engineering technicians continued, with definitions developed to meet both operating and training employee development needs.

During the annual performance evaluation period in February, the personnel and training officers conducted seminars on the rating of employees with all supervisory personnel in three districts. In May, the division co-operated with seven other state agencies in a pilot study on proposed new method of performance evaluation which embodies greater emphasis on employee development, as well as improvement of performance on the job. Preliminary reports indicate a favorable reaction from employees.

Standardization of personnel programs and procedures throughout the division has received continued emphasis through training programs and visits to the districts by representatives of the headquarters personnel office.

Recruiting

The major recruitment emphasis this year was again on the entering professional engineer level, junior civil engineer, with about 75 being employed from this year's graduating class. Summer use of engineering students was continued. A few new engineering student trainees were hired. Most of the students from the previous summer returned for additional work and training.

The continuous testing program for junior right-of-way agents was augmented, with satisfactory results. Newly developed performance testing for equipment operators has increased the caliber of eligibles on these employment lists.

Staffing Statistics

The total number of employees in the division increased from 13,828 on July 1, 1959, to 14,057 on July 1, 1960, including 6,948 in engineering work, 3,634 in maintenance, 488 in right-of-way, 474 in equipment, and 2,513 in accounting, clerical and miscellaneous jobs.

Ninety employees were presented with 25-year service awards and pins during the year, and 127 employees retired.

Twenty-two employees were dismissed in disciplinary actions, of whom 5 had permanent status and 17 temporary status. Forty-nine employees were suspended for various causes. Nineteen probationary employees were rejected.

Foreign Visitors

During this year, tours for 99 representatives of 29 countries were arranged in various departments and districts, most of them assigned to the division by the U.S. Bureau of Public Roads and other agencies.

TRAINING

The personnel management policy of the State of California and of the Department of Public Works states with respect to training:

"Training. A planned program is required to develop the employee knowledges and skills necessary to meet the needs of the agency and of state service, and to keep abreast of constant advances in science and technology. Particular attention must be given to developing the managerial talent necessary to cope with the increasingly complex functions of state government."

During the year, training programs were conducted in the major areas of orientation, supervision and management, professional and technical engineering and right-of-way, maintenance, and clerical. There were 164,046 hours of formal training: 102,163 on state time, and 61,883 on the employees' own time.

Supervision and Management

In connection with the work improvement program, 3,450 supervisors received special training. There were estimated savings of more than $263,000 as a result of adopted work improvement suggestions.

Eight division employees, representing top management, took part in the annual Interagency Management Conference sponsored by the Governor.

Other supervisory training programs included performance report training for 556 supervisors; a trial run for a new system of individual development plans; participation in the State Personnel Board "Training the Trainers" course; an experimental supervisory development plan in which employees rated supervisors; and supervisory workshops and seminars. Total training time for all supervisory and management training was 25,030 man-hours.

Professional and Technical

Several formalized professional and technical training programs were conducted during the year.

A 12-hour course in drainage design in highway practice, given through the University of California's Institute of Transportation and Traffic Engineering, was attended by 582 persons on their own time.

Advanced transistor electronics was covered in a course attended by 128 persons. The course included 48 hours of demonstration and lecture, plus laboratory assignments.

All senior right-of-way agents were trained as instructors for workshop sessions dealing with right-of-way negotiations. Junior, assistant and associate agents participate in these monthly meetings at which methods and case studies are considered.

During the first two years of employment, junior civil engineers are given training assignments in design, construction, surveys, and other aspects of highway engineering. This rotation program continued during the year.

The professional and technical courses (excluding rotation) and other formal programs accounted for 75,547 man-hours, of which 20,555 were on the employees' own time.

Ninety-seven persons took part at state expense in short courses presented by various schools, including courses in real estate appraisal and condemnation, traffic engineering, motor vehicle maintenance and supervision and asphalt paving.

The various sections and units of the division sponsored 59,128 hours of training, 49,904 hours on employee-time. Among these was a comprehensive correspondence course in bridge design which was completed by 112 bridge engineers. The course required about 200 hours for each participant.

EMPLOYEE SAFETY

The preparation, organization, and supervision of the statewide highway employee accident prevention program seeks to promote accident prevention methods, to prevent industrial accidents and injuries, and to prevent accidents involving state owned motor vehicles.

Full-time safety supervisors are assigned in 10 of the 11 districts. A part-time employee handles the job in one district. Part-time safety supervisors also serve in the bridge, service and supply, toll bridge, laboratory, and equipment departments.

The safety supervisors advise personnel regarding accident prevention practices, recommend protective devices, and conduct inspections to see that there is compliance with rules relative to good health, safety, and fire prevention.

The various districts and departments have a safety committee which meets monthly and reviews accident reports to determine appropriate action to prevent recurrence.

Minutes and statistical information from these meetings are submitted to the Headquarters Safety Section each month where they are consolidated and presented to the Division Safety Committee.

The Division Safety Committee acts on matters presented by the districts and considers other subjects relative to the program at regular monthly meetings.

Occupational Accidents

All accidents involving division personnel or equipment are coded, and monthly and annual statistical reports prepared. Standard methods of recording and measuring work injury experience, as approved by the American Standards Association, are used for coding. Frequency and severity rates are compiled and used to indicate the effectiveness of the safety program. The division's accident frequency rate has been going down each year since 1940 when the rate was 49.85. In 1959 the frequency was 12.51. The number of employees has increased from 5,500 in 1941 to 13,343 in 1959.

The reduction in accident frequency has been paralleled by a comparable reduction in compensation cost. In 1950 compensation cost was 58 cents for $100 of payroll; in 1959 it was 37 cents with a payroll amounting to $88,706,717.



The Employee Safety Section is conducting an extensive driver training program for employees who operate state automobiles in connection with their jobs. Special equipment is used to test reaction time (left), check peripheral vision (center), and to determine depth perception.

Motor vehicle accidents involving state cars are also coded and analyzed. For several years defensive driving techniques have been promoted, and special equipment has been used to determine visual limitations and reaction time. Information thus determined is called to the attention of the employee to indicate any restrictions or limitations for which he should compensate in his daily driving.

In 1959 division cars traveled 68,219,191 miles. The accident frequency rate was 0.65. The division has achieved consistently lower frequency rates since 1950.

Driver Training

All state agencies have been instructed by Governor Brown to start courses in defensive driving. Every employee who drives a state car is required to take the course.

The course consists of a three-hour lecture, psychophysical tests consisting of a check of peripheral vision, color vision, judgment of distance, visual acuity, and reaction time, and an actual road test in which the skill, habits, and attitudes of the driver are observed.

After June 30, 1961, no employee may drive a state car who has not had this training. The program is now well under way with three representatives of the Safety Section in headquarters co-ordinating the training in various districts and departments.

Fire Control

Fire control demonstrations were held during the year covering the use of fire extinguishers for various types of fires. Employees actually practice putting out fires with the different extinguishers during these sessions. The testing of water- and foam-type extinguishers, which started in 1959, was completed.

Employee Suggestion Program

During the year, 530 suggestions were referred to the Division of Highways for investigation and report under the Merit Award Program. Fifty-four were adopted with 49 employees being given cash awards and 30 receiving certificates of commendation. Seventy-three Work Improvement Program suggestions were reviewed, and 48 cash awards and 19 certificates were authorized.

AUDIO-VISUAL

The Audio-Visual Section assists all headquarters departments, as well as the various districts, in producing graphic or sound recording aids for personnel training or public information uses.

A large collection of colored slides covering statewide highway scenes and a wide variety of technical engineering and construction operations is kept up to date. Audio-Visual equipment is available for use by headquarters or district personnel in training or public presentations.

The Audio-Visual Section is staffed to produce any type of graphic material from newspaper maps to complicated or technical art reproductions. It also produces and conducts experiments for new methods of transparency projection material, from slides, sound-filmstrips, and motion pictures, to animation and combination slides.

PUBLIC INFORMATION

Public interest in various aspects of the state highway program continued at a high level throughout the fiscal year, with particular emphasis focused on the relationship of urban freeways to overall metropolitan transportation planning. More time and attention was devoted to this subject than to any other at statewide meetings and conferences on highway matters. One such conference was called by the Governor for the purpose of bringing community planning officials and highway engineers together.

The Division of Highways co-operated with the California Highway Patrol in publicizing the maximum 65-mile-an-hour speed limit which became effective January 1. A news release was published by many newspapers in the State, accompanied by an appropriate photograph in mat form. The picture showed a maximum speed limit sign near the Nevada state line on U.S. Highway 40. The change in the law necessitated creation of numerous new speed zones in locations where the former 55-mile prima facie limit applied, and press releases concerning them were issued by the districts.

In July 1959, when advertising of projects was curtailed because of federal financing problems, and again several months later, when nearly full-scale advertising was resumed, many inquiries were received from the press and trade publications as to the effects on California's highway program. This was in addition to basic information on the matter disseminated in press releases.

State Fair Exhibit

After a lapse of some years the division resumed placing an exhibit at the California State Fair. The 1959 exhibit, "Freeways for You—Now and in 1980," was arranged in a 12- by 20-foot booth in the Industrial Building and drew the attention of thousands. It featured models of depressed and elevated urban freeways. A map of the California Freeway and Expressway System was displayed.

Magazine Publication

The bimonthly magazine *California Highways and Public Works*, while devoted almost entirely in recent years to the activities of the Division of Highways, has always been edited in the Department of Public Works office. In September 1959, responsibility for the magazine was assigned by the Director of Public Works to the State Highway Engineer, and the public information staff in the director's office was consolidated with that of the Division of Highways.

Publications

The Public Information Section became responsible for the dissemination of publications, as defined by the State Administrative Manual, to depository libraries. These include reports to the Legislature and other material reproduced by means other than printing, but do not include typewritten reprints or material intended only for use within the agency. The State Printing Office distributes printed material.

Public information material issued in published form included, in addition to regional material prepared by the various districts:

"California Highways—1959," a 16-page reprint from *California Highways and Public Works* magazine constituting a popularized, nontechnical version of the division's annual report.

"Freeway Facts," an illustrated booklet containing basic information about freeways and route adoption procedures, widely used at district public meetings.

Reprints of articles and district roundups published in *California Highways and Public Works* were used as information mailing pieces to answer a wide range of inquiries.

"Clip Sheet" for employee publications issued by all districts and some headquarters departments. The *Clip Sheet*, issued monthly, provides information of interest and value to division employees, intended for use in the employee publications as desired by the respective editors.

Route Considerations

News releases on routings considered and acted on by the California Highway Commission totaled 97 during the year, of which 41 were accompanied by maps specially prepared for newspaper reproduction. Due advance publicity was given seven public hearings scheduled and held by the commission, as well as two which were scheduled for the following fiscal year.

Other News Releases and Media Contacts

The quantity and scope of news releases issued by the division, particularly by the district offices, continued the increase shown in previous years. At the same time, releases from headquarters covered the full range of division activities and Highway Commission actions of interest to the public.

In all, more than 1,500 separate news releases were issued during the year, including more than 1,100 by the various districts. Maps or other illustrations, usually in mat form, accompanied a number of these releases.

A large number of photographs of highway projects were supplied to newspapers, magazines and other publications on request, particularly on major freeway work in the metropolitan areas and on rural projects of significant size.

Other Contacts and Appearances

Considerable information on the highway program was issued through telephone calls, office interviews, and appearances by division personnel on radio and television programs.

Division personnel also continued to appear on invitation before local civic organizations and service clubs. Many of the speakers illustrated their talks with 35 mm. slides showing local and statewide highway developments.

RIGHT-OF-WAY

The Right-of-Way Department acquires the right-of-way needed for state highways; manages such property in the preconstruction period; and arranges for the removal or relocation of utilities and improvements.

There was an average of 466 individuals working in right-of-way classifications during the 1959-60 fiscal year.

Program

During 1959-60, the Right-of-Way Department completed 7,792 property transactions involving a total expenditure of $129,646,470.28. Of these transactions, 7,052 were parcels, or separate ownerships, of real property acquired for highway rights-of-way, and 571 involved utility relocations. The remaining 169 transactions consisted of acquisition for other uses and for other state agencies.

Total expenditures were distributed as follows:

Highway right-of-way	$102,994,975.94
Utility relocation	8,052,005.87
Acquisition other than highway right-of-way	7,739,941.74
Overhead (all functions)	10,859,546.73
Total	$129,646,470.28

Condemnation Record

The firm policy in all highway right-of-way acquisitions in California is to give property owners ample time to consider a settlement offer and to make necessary preparations for readjustment. No condemnation actions are initiated until it is clear that reasonable time for deliberation and decision has been afforded.

Equal emphasis is given to thorough appraisals and negotiations to make sure that fair market value is paid for all properties acquired.

One very clear indication of the acceptance of these policies is provided by the acquisition figures for the year. Of the 7,052 parcels acquired, only 159 or 2.3 percent were secured through contested eminent domain proceedings.

Amicable settlements were achieved in the remaining negotiations, even though title questions or other circumstances may have required initiation of the condemnation procedure.

Average Cost Per Parcel

An interesting commentary on California's economic expansion over the last 15 years is reflected in the following tabulation of land unit cost increase measured by related dollar volume:

Year	*Average cost per parcel*	*Percentage of increase over 1945*
1945	$2,370.51	
1950	6,915.81	192
1955	9,789.57	313
1960	15,689.16	562

While decreased buying power of the dollar must be considered, plus the fact that recent years have seen increasing freeway development in built-up areas, the increase in market value is largely attributable to conversion of land uses to higher functions, with higher potential return on investments.

Property Management

Property management includes the leasing of property held during the period between acquisition and clearance for construction; disposing of improvements; and the selling of "excess" properties acquired to reduce or eliminate payment of excessive damages.

Excess parcels are acquired in cases where severance damage to the remainder of a parcel would represent 70 percent or more of the fair market value. During the past several years, it has been to the advantage of both the State and the property owner to acquire the entire parcel when these conditions exist; and upon completion of highway construction, to dispose of the excess through the usual sealed bid procedure.

There were 7,689 parcels under lease at the start of the year, and 7,943 when the year ended. Sales of excess property, including improvements, totaled 3,835. Leases and sales during the 1959-60 fiscal year produced a gross return to the State Highway Fund of $12,018,516.52.

Public Land, Revolving Fund, Utilities

Right-of-way and material sites on United States public lands are acquired under various federal statutes. While cash payment is not usually required, processing is lengthy and complicated.

During the year, 4,392 acres of right-of-way, together with material sites totalling 11,722 acres, were transferred from federal to state jurisdiction. Land value of the right-of-way, if obtained from private ownership, would range from $100 in remote areas to upward of $20,000 per acre for urban properties.

The 11,722 acres of material sites constitute a potential source of up to 100,000,000 cubic yards of road building materials. Corresponding market value of these materials could approximate $10,000,000.

Highway Right-of-Way Acquisition Fund

The 1952 Legislature established the special revolving fund for the advance purchase of right of-way. The fund permits acquisition of essential right-of-way on which costly improvements are planned, facilitating orderly development and resulting in large savings.

The California Highway Commission had authorized the expenditure of $43,288,021 for acquisition of rights-of-way for future needs by the end of the year. Estimated cost to the State would have been $258,339,184 for this property if planned development had gone ahead.

An essential adjunct to acquisition and clearance of rights-of-way is the relocation of utilities. Five hundred seventy-one utility agreements were entered into during the year. Under the terms of these and prior agreements, reimbursement to affected utility companies for necessary relocation work totaled $8,052,006. In addition, obligations amounting to $13,140,583, were incurred.

Personnel

The division's extensive land acquisition program requires personnel experienced in land valuation and nego-

tiation. It has been demonstrated during past years that the only means of acquiring such personnel is by a continuous personnel-development program.

Two programs have been developed and used, specialized training and in-service training. During the year, 51 employees completed 4,410 hours of formal instruction in colleges and universities. Approximately 20,000 hours of inservice instruction were received by some 350 agents, an increase of about 17 percent over the previous year.

Employees are also encouraged to participate in the activities of various professional associations including the American Right-of-Way Association, bar associations, and appraisal societies.

This program has been successful in developing skilled right-of-way agents. However, the demand for trained personnel by other public and private agencies has resulted in excessive turnover in personnel. During the year the termination figure was more than 14 percent of the total staff. This high termination rate, plus the impossibility of recruiting experienced personnel, is a continuing serious problem.



Recently realigned four-lane section climbing out of the main wash of Red Rock Canyon on U.S. Highway 6 about 25 miles north of Majave, Kern County.

Land Economic Studies

During the past year, research into several areas of major significance to right-of-way representatives was continued by the Land Economic Studies Section.

One study covered "remainder parcels," the property remaining after a portion of a land parcel has been acquired for a freeway. These remainder parcels, when sold or developed, are excellent indicators of freeway benefits or damages. They are being painstakingly studied and documented to provide a sound case study basis for future right-of-way appraisals. (Twenty-three freeway projects involving more than 3,300 parcels had been analyzed by the end of the year.)

Another study involved freeway effects upon abutting residential properties located in one of the older sections of a major metropolitan complex. The study can be expected to provide information on the effects of freeways on the values of older residences, and on possible land use changes following freeway development.

During the year, several other surveys were completed. Chief among these was a locational aid analysis, which involved investigation of what happened to people, homes and businesses displaced by a freeway. Where people resettled, the effects of relocations upon community taxes, and the probable effect of the freeway on the study community were some of the elements which received careful consideration. Other locational aid surveys and analyses, dealing with route location problems, were conducted in Sacramento, Pasadena, Pomona, Seaside, and Turlock.

Motel and service station location in relation to a freeway was investigated. Traditional locational theory for these land uses was carefully reviewed in the light of current freeway developments and industry trends. The initial summation was published in the May-June 1960 issue of *California Highways and Public Works* under the title "Motels—How Important are Accessibility and Visibility to Business Success?" Immediately after publication, the report was almost wholly reprinted in a leading trade publication.

Requests for California land economic study data, advice, and assistance have continued in about the same volume as in previous years. Approximately 3,500 reprints of land economic summation reports were sent upon request to university and college faculty members, government agencies, businessmen, students, home owners, etc., in 35 states and three foreign countries.

LEGAL

The Division of Contracts and Rights-of-Way is the Legal Division of the Department of Public Works and renders a variety of legal services to the Department and its Division of Highways.

The following tables indicate the volume of work performed by the Legal Division, involving court appearances and hearings before various administrative agencies for the past fiscal year:

Condemnation Proceedings

Suits filed	298
*Parcels involved	1,776
Defendants involved	5,965
Suits closed	358
Trials	123
Uncontested judgments	113
Suits pending 6-30-60	417
Parcels pending 6-30-60	2,294

* (The parcel count differs from that of the Right of Way Department's computations which are based upon appraisal parcels. The above computation is based upon a count of parcels in the condemnation resolution).

Appellate Cases

During the fiscal year many appellate court briefs were prepared by the division and appeals argued. Decisions have been rendered in *Griffith* v. *Department of Public Works*, 52 Cal. (2d) 848; *Yarrow* v. *State of California*, 53 A.C. 433; *People* v. *Avon*, 54 A.C. 210; *Vinnicombe* v. *State of California*, 172 Cal. App. (2d) 54; *People* v. *Murray*, 172 Cal. App. (2d) 219; *People* v. *Bowman*, 173 Cal. App. (2d) 416; *Redwood* v. *State of California*, 177 A.C.A. 569; *People* v. *Murata*, 179 A.C.A. 587; *People* v. *City of Los Angeles*, 179 A.C.A. 629; *People* v. *Chastain*, 180 A.C.A. 836; *People* v. *Nogarr*, 181 A.C.A. 369; and *People* v. *Symons*, 182 A.C.A. 6.

Also, amicus curiae briefs were filed by the Department of Public Works in the condemnation cases of *County of Marin* v. *Superior Court*, 53 A.C. 868; and *Covina Union High School District* v. *Jobe*, 174 Cal. App. (2d) 340.

Several other cases are pending before the Supreme Court and the district courts of appeal, either awaiting argument or decision.

An important decision was rendered by the California Supreme Court in the case of *People* v. *Avon*. There, the defendants' property fronted upon Azusa Avenue in the City of Azusa. The State proposed to make Azusa Avenue a one-way street, starting just north of the defendants' property. A street to the west of the property was made a one-way street and connected to Azusa Avenue just north of the property. A divider strip was placed on Azusa Avenue to separate the traffic. The defendants claimed that the construction was an interference with their access and that as a result they had lost business and customers. In addition, they claimed losses arising from the construction of the improvement in that they claimed that the State would not construct the improvement in the time and manner proposed by the State.

The Supreme Court held that there was no interference with access and that in the interests of safety and traffic control it is often necessary to make changes in the existing streets, such as divider strips, one-way streets, etc. The court ruled that a property owner does not have an absolute right to the street in front of his property in its existing condition, and that there is no liability by the State where the property owner retains a reasonable means of ingress and egress from his property. The court also held that the construction of the improvement to be considered in awarding damages was that proposed by the Division of Highways, and that any temporary interference with access where necessary is permissible without compensation having to be paid to the property owner.

Another important decision was handed down in the case of *County of Marin* v. *Superior Court*. A municipal water district desired to construct a dam and reservoir which would have inundated two portions of county roads which were part of the Federal Aid Secondary System. The superior court granted the water district's motion for an order authorizing it to take possession of the roads and to commence construction. The county petitioned for prohibition and certiorari to the State Supreme Court to restrain the Superior Court of Marin County from proceeding with the eminent domain proceedings. Because of the issues involved, the Department of Public Works filed an amicus curiae brief on behalf of the County of Marin.

The Supreme Court concluded that property of a county already appropriated to a public use, such as the county roads in question, was exempt from condemnation by a municipal water district. Due to the emphasis placed upon the question by the department's brief, the court examined the impact of the Federal Highway Act and state legislation pursuant thereto upon the statutory authority of the trial court in a condemnation proceeding to regulate and determine the place and manner of removing or relocating federal aid highways. The court was explicit in holding that the Federal Highway Act precludes a municipal water district and the superior court from selecting routes and adopting specifications relating to the relocation of county roads in the Federal Aid Secondary System.

Another decision was rendered by the California Supreme Court in the case of *Griffith* v. *Department of Public Works*, 52 Cal. (2d) 848; 345 P. (2d) 469. The State, in building a freeway through the City of Los Angeles, had commenced condemnation of the interests of the city and plaintiff in the portion of Griffith Park through which the freeway was constructed. The State was in possession and the freeway virtually completed. The plaintiff, as taxpayer and owner of a contingent future interest in part of Griffith Park, sought to prevent state freeway construction therein on the ground that the land had been granted to the City of Los Angeles for public park purposes only. Plaintiff appealed to the Supreme Court. The judgment of the trial court was affirmed. The Supreme Court held that an injunction will not issue to prohibit a completed act such as the building of a freeway.

Other Litigation

At the start of the fiscal year there were 438 cases pending, and another

514 were filed during the year for a total of 952 in process. There were 426 cases closed during the year, leaving 526 cases pending on June 30, 1960.

Some of these cases involved claims for damage to state highway facilities, such as bridges, signals, guardrails, or damage to state vehicles, or unlawful detainer actions. During the fiscal year collections by the Legal Division amounted to $168,227.98. This is an increase of over $100,000 above what was collected during the preceding fiscal year. A substantial portion of this increase was due to the collection by the State of the damage to the Antioch Bridge on December 31, 1958, caused when the steamship collided with the bridge.

The case total also includes many matters where the department is represented, as a defendant, such as inverse condemnation proceedings for damage to property by reason of the state highway operations as alleged; suits by contractors for additional compensation on construction contracts, and suits filed because of alleged dangerous or defective condition of state highways.

In still other types of suits, such as stop notice actions, the department has filed interpleader actions in which it has taken a neutral position between the contractor and the claimants.

Board of Control and Other Claims

	Number of claims	*Amounts*
Pending July 1, 1959	103	$6,787,481.33
Filed	128	4,124,008.02
Totals	231	$10,911,489.35
Disposed of	150	7,761,696.77
Pending June 30, 1960	81	$3,149,792.58

The principal types of Board of Control claims as listed above are for negligence, breach of contract, and inverse condemnation.

Other claims filed with the department's employees and the Governor numbered 32.

Contractors' claims before the State Highway Engineer's Board of Review for additional compensation have increased notably. These claims have required considerable work, both in the studying and handling of the claims as well as resulting litigation.

The "house counsel work" of the division has also shown a decided increase. This work consists largely of legal opinions directed toward preventing litigation rather than engaging in litigation after damage has occurred. This included 13 contested hearings before the State Personnel Board.



This new section of freeway eliminated the final gap in continuous freeway on Sign Route 17 through San Jose. Photo shows traffic separation structures which take the Nimitz Freeway over the former Bayshore Highway (center) and the new Bayshore Freeway lanes.

ACCOUNTING

Administration of all accounting and internal audit activities of the Division of Highways is under the direction of the Comptroller of the Department of Public Works and his staff.

Cash Resources and Obligations

On June 30, 1960, cash and securities on hand amounted to $165,389,672, with $135,566,488 of the amount being invested in United States government obligations. On the same date, there were outstanding budgetary obligations of $280,037,081, of which $31,776,593 were advance obligations against revenues of the 1960-61 fiscal year.

Revenues and Expenditures

Revenues budgeted for the 1959-60 fiscal year amounted to $652,699,954, of which $210,439,576 remained to be collected on June 30, 1960. Collection of the revenue not received, which consists of $195,334,076 of federal aid and $15,105,500 of contributions from state and local agencies and other sources, will be made as work against which the amounts apply is completed. Revenues budgeted for the prior fiscal year amounted to $534,469,148.

Expenditures and obligations incurred during the fiscal year ended June 30, 1960, amounted to $580,464,870 as compared to $517,636,201 for the prior fiscal year.

Accounting System and Procedures

The following new accounting procedures and systems and changes in existing procedures were put into effect during the year because of new legislation, to accommodate increased or special activities or to provide more effective control over operation, as follows:

(1) A system of accounts was instituted to provide for recording transactions relating to the Highway Properties Rental Fund, created by Chapter 2157, Statutes of 1959. This chapter requires the segregation in a special fund, for ultimate distribution to the state and local agencies, of all rents collected on right-of-way properties acquired for future needs, except properties acquired for the National Interstate Highway System and toll bridges.

(2) An overall revision of the system of control accounts in use was made to bring the system into conformity with the new state uniform system of accounts prescribed by the Department of Finance.

(3) Accounting procedures were established in connection with the granting of state aid for local agency streets and roads in urban areas qualifying as extensions of the Federal Aid Secondary System, under Section 143.3 of the Streets and Highways Code, which was added by Chapter 1719, Statutes of 1959.

(4) A new allotment and work authorization numbering system, with corresponding changes in budgetary procedures and the system of control accounts, was instituted, effective July 1, 1960, in order to meet the requirements of electronic data processing equipment and to provide for logical expansion in connection with budgetary and other changes necessitated by new statutes.

(5) The procedure relating to new traffic striping and pavement markings and the installation of warning and regulatory signs was changed to provide for separate budgeting and accounting of such work as construction items. This change was required by amendment of Section 27 of the Streets and Highways Code by Chapter 113, Statutes of 1959, redefining work classified as maintenance.

(6) Further investigation of the possibilities of use of electronic data processing equipment to facilitate and expand the accounting and reporting procedures was made during the year. In the 1960-61 fiscal year a pilot test will be made in District X for a short period to work out the mechanical and procedural problems involved. It is tentatively planned to convert to punchcard accounting on a statewide basis by July 1, 1961.

1961-62 Budget

Total of $633,460,812 Includes $509,078,312 for Construction

THE CALIFORNIA HIGHWAY COMMISSION has adopted a record $633,460,812 state highway budget for the 1961-62 fiscal year.

The budget contains $509,078,312 for state highway construction purposes, including rights-of-way.

The previous budget, adopted in October 1959 for 1960-61, contained a gross total of $569,244,000 of which $452,785,000 was for construction purposes. The corresponding 1959-60 totals were $610,712,000 and $497,000,000.

State Director of Public Works Robert B. Bradford, commission chairman, said the record budget reflects increases in federal highway apportionments and in estimated revenue from state sources.

The total 1961-62 federal highway apportionment to California is $273,570,812, including $220,070,812 for work on interstate highways. The 1960-61 apportionment was $227,708,867 of which $181,086,840 was for the Interstate System.

Estimated revenue from state sources is up about $18,000,000 from the previous year as a result of the State's constantly increasing motor vehicle registration and use.

Projects Carefully Selected

Bradford said the projects in this record budget were carefully selected to meet urgent local and regional needs and to fit into long range plans for orderly statewide highway development. The budget provides for construction of 240 miles of multilane freeway and expressway, plus 42 miles of two-lane access-controlled highway and many additional miles of conventional highway and other improvements.

"These budgeted improvements," Bradford said, "will provide direct benefits to California citizens all over the State.

"Newly budgeted freeway sections in our cities," he said, "will reduce the traffic load on local streets, making things easier for the shopping housewife and her commuter husband, and safer for their children going to school.

"When this year's program is completed, transportation will also be more efficient for farmers, businessmen and manufacturers, and it will be safer and less difficult to drive to some of our major recreation areas," he said.

Bradford pointed out, however, that no single fiscal year budget could possibly take care of all of the State's critical highway deficiencies.

"Inevitably, many greatly needed improvements could not be financed this year. For example, the list of urgent projects submitted to the Highway Commission recently by the California State Chamber of Commerce would cost several billion dollars to construct. We are satisfied, however, that this is the best possible budget within the limit of available funds," he said.

Major Sources Listed

Major sources of state-collected highway revenue expected for 1961-62 include $263,967,000 in gasoline taxes (up about $10,500,000 from the previous year's estimate); $56,596,000 in motor vehicle fees (up $3,500,000); $24,800,000 from the use (diesel) fuel tax (up $2,500,000); and $13,200,000 from transportation taxes on for-hire carriers (up $1,700,000).

The budget contains $56,105,500 for functions other than state highway work.

The largest item in this category is $35,501,000 for major city streets other than state highways, based on five-eighths cent per gallon of the state gasoline tax. Other nonstate highway items are:

Federal aid for county roads on the Federal Aid Secondary System, $8,312,500; state funds to counties for use in matching these federal funds, $4,500,000; state funds to help finance railroad grade separation projects on local streets and roads (not state highways), $5,000,000; engineering funds to cities, $1,500,000; and state funds to pay part of the cost of urban extensions of FAS county roads, $1,292,000.

Bradford pointed out that California's 58 counties receive 1⅜ cents per gallon from the State's 6 cents per gallon gasoline tax, plus a portion of the motor vehicle fees.

Funds Disbursed Directly

These funds are disbursed directly by the State Controller and are not listed in the State Highway Budget. For the 1961-62 fiscal year, these state funds for county roads will total an estimated $91,750,000. Another $1,100,000 per year from the gas tax is earmarked by law for airports and small craft harbors.

The $509,078,312 in the budget for highway construction purposes includes:

Major construction and improvement (contracts plus engineering), $348,072,000; rights-of-way, $145,926,000; contingencies (normally available for construction purposes), $7,280,312; resurfacing program, $5,000,000; signs and striping, $2,000,000; and minor improvements, $800,000.

Proposed expenditures for state highway purposes other than construction include: maintenance, $41,500,000; buildings and plants, $9,000,000; administration, $10,900,000; statewide highway planning survey, $2,000,000; maintenance of state toll bridges, $3,000,000; and honor camps, $1,750,000.

The 1961-62 budget contains 28 landscaping and planting projects for which a total of $3,317,000 is budgeted. Another $2,051,000 is included for 10 projects to install median barrier on heavily traveled metropolitan area freeways, mostly in the Los Angeles region.

1961-62 State Highway Budget Projects by Counties

NOTE 1: Construction contracts may be awarded beginning January 1, 1961. Right-of-way funds may not be expended until July 1, 1961 (start of fiscal year).
NOTE 2: Projects which overlap county lines are listed under both counties.

County	Route†	Description	Approx. mileage	Estimated cost
Alameda	US 50	MacArthur Freeway—Park Blvd. to Buell St. in Oakland; grade, pave and structures for 8-lane freeway (This project, together with work now under way or budgeted, will complete MacArthur Freeway for 6.5 miles from East Bay Distribution Structure to Buell St.)	3.0	$8,700,000
Alameda	US 50	MacArthur Freeway—Kuhnle Ave. to east city limit of Oakland near Durant Ave.; grade, pave, and structures for 8-lane freeway	3.5	8,000,000
Alameda	SR 17	Nimitz Freeway—0.7 mile south of Central Ave. in Fremont to 1.1 miles north of Thorton Ave. in Newark; landscape	2.3	120,000
Alameda	HR 107	Niles-Centerville Rd.—Main St. to SR 9 in Fremont; grade and pave to reconstruct	2.5	95,000
Alameda	SR 21	SR 9-21 north of Mission San Jose to HR 107 at Scott's Corner near Sunol; grade, pave and structure for 4-lane freeway	4.7	6,200,000
Alameda	HR 226	Existing Posey Tube between Oakland and Alameda; dredging and backfill		300,000
Alameda	HR 227	Warren Freeway—Lincoln Ave. to Redwood Rd. in Oakland; landscape	1.0	50,000
Alameda	HR 227	Warren Freeway—Moraga Ave. Interchange in Oakland; grade, pave and structure for interchange	0.4	500,000
Alameda	FAS 1030	Redwood Rd. between Castro Valley Blvd. and Grove Way northeast of Hayward; grade and surface to widen to four lanes (Urban extension of FAS County Rd.; county's share $183,000)	0.8	183,000 (State's share)
Alameda	Various	Rights of way including $5,380,000 for US 50 freeway in and south of Oakland, $2,800,000 for Grove-Shafter freeway in Oakland		9,850,000
Alpine	Various	Rights of way		45,000
Amador	SR 88	2 miles east of Peddler Hill to 2.5 miles east of Corral Flat; grade and pave to reconstruct, widen and realign for access-controlled 2-lane highway	5.9	1,000,000
Amador	SR 16	0.3 mile west of junction with SR 104 (Waites Station) to 0.2 mile east of Junction with SR 49 (Central House); grade and pave to reconstruct, widen and realign for initial 2 lanes of future 4-lane expressway	2.3	410,000
Amador	Various	Rights of way		150,000
Butte	US 40 Alt.	Oroville to 0.7 mile east of Wick's Corner; grade, pave and structures for 4-lane freeway	6.8	4,650,000
Butte	US 40 Alt.	1.0 mile north of Adelaide to Oroville; grade, pave and structures for 4-lane freeway. (This project and previously listed job will provide 8.6 miles of freeway connecting with relocated US 40 Alt. at Wick's Corner)	1.8	1,280,000
Butte	Various	Rights of way including $650,000 for future US 99E freeway in vicinity of Chico		900,000
Calaveras	Various	Rights of way		215,000
Colusa	US 99W	South city limit of Williams to Maxwell; resurface	9.2	200,000
Colusa	SR 20	Colusa Basin Bridge west of Colusa; replace narrow bridge and construct approaches	1.5	530,000
Colusa	SR 20	10th St. to Bridge St. in Colusa; resurface	0.8	45,000
Colusa, Yolo	SR 45	3.5 miles south to 4.5 miles north of Yolo-Colusa County line; grade and pave for reconstruction, widening and some realignment	8.0	700,000
Colusa	Various	Rights of way		190,000
Contra Costa	US 40	At Carquinez Bridge-Crockett Interchange; landscape	0.3	39,000
Contra Costa	SR 24	East portal of Caldecott Tunnel to 0.4 mile west of Orinda Highway; grade, pave and structures for 8-lane freeway	2.0	7,500,000
Contra Costa	SR 24	Monument to north of Concord Ave. in and near Concord; grade, pave and structures for 4-lane freeway	2.0	2,300,000
Contra Costa	SR 21	Monument to Arnold Industrial Highway; grade, pave and structures for 4-lane freeway. (This project, together with two previously listed and current Benicia-Martinez Bridge and approach construction, will complete freeway development for about 30 miles from Caldecott Tunnel in Oakland to US 40 at Vallejo)	4.2	4,410,000
Contra Costa	FAS 1326	Willow Pass Rd. between Pacheco Blvd. and newly budgeted Sign Route 21 freeway near Concord; grade and surface for 4-lane divided highway (urban extension of FAS County Rd.; county's share $35,000)	0.4	$35,000 (State's share
Contra Costa	Various	Rights of way including $920,000 for SR 21 freeway south of Walnut Creek		2,045,000
Del Norte	US 199	8.8 miles south to 1.1 miles south of Oregon border; grade and pave south approach and pave north approach to Oregon Mountain Tunnel	4.2	2,955,000
El Dorado	SR 49	0.7 mile south to 0.9 mile north of Hastings Creek Bridge; grade, pave and structure to realign (includes bridge replacement)	1.6	335,000
El Dorado	HR 93	Top of Morgan Grade to Cool (portions); grade and pave to realign		50,000
El Dorado	Various	Rights of way including $500,000 for US 50 freeway west of Pollock Pines		855,000
Fresno	US 99	0.3 mile north of Chestnut Ave. to San Joaquin St. in and south of Fresno; grade, pave and structures for 6-lane freeway	5.5	6,600,000

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County	Route†	Description	Approx. mileage	Estimated cost
Fresno	FAS 815	Jensen Ave., between Lyon Ave. and West Ave. in Sanger; grade and surface to construct 4-lane highway (urban extension of FAS County Road; Sanger's share, $39,500)	0.5	39,500 (State's share)
Fresno	FAS 1211	Belmont Ave. between Fisher Ave. and Chestnut Ave. in East Fresno; grade and surface to construct 4-lane divided highway (urban extension of FAS County Road; City of Fresno's share, $83,000; Fresno County, $85,000)	1.9	168,000 (State's share)
Fresno	Various	Rights of way including $3,455,000 on US 99 between Tulare County line and Fresno		3,964,000
Glenn	Various	Rights of way		480,000
Humboldt	US 101	Maple Hills Rd. Bridge to Myers Flat; grade, pave and structures for 4-lane freeway. (Eel River Bridge and some grading already in progress on this section) (connects with 11.5 miles of freeway to the north)	5.6	6,169,000
Humboldt	US 299	12.5 miles east of Blue Lake to 0.4 mile east of Green Point; base and pave on section graded by Honor Camp crew	2.5	165,000
Humboldt	SR 36	South Fork Van Duzen River Bridge east of Bridgeville; replace bridge and construct approaches	0.2	120,000
Humboldt	SR 36	Between 5.5 miles and 5.9 miles east of Bridgeville; grade and pave to widen	0.4	76,000
Humboldt	SR 96	3.8 miles to 18.7 miles north of Willow Creek (portions); replace timber cribs		70,000
Humboldt	Various	Rights of way		305,000
Imperial	US 80 and US 99	At Trifolium and Tamarack Canals on US 99 northwest of Brawley, and at Lowline Canal on US 80 east of Holtville; replace bridges		150,000
Imperial	SR 115	Standard Canal to SR 111 at Calipatria; grade and pave to reconstruct and widen	7.2	650,000
Imperial	Various	Rights of way		650,000
Inyo	US 395	1.9 miles south of Keough's Hot Springs to 4.1 miles south of Bishop; grade and pave to relocate as 2- and 4-lane expressway	5.4	500,000
Inyo	Various	Rights of way		10,000
Kern	US 99	2.3 miles south of Reserve Rd. to future junction with Westside Freeway; grade, pave and structures to convert from expressway to 4-lane freeway (connects with new Grapevine Grade freeway)	4.8	1,100,000
Kern	US 99	Future Westside Freeway junction to SR 33-166; construct frontage roads to convert to 4-lane freeway	2.8	55,000
Kern	US 99	0.1 mile south of Ming Ave. to Norris Rd. in and near Bakersfield; grade, pave and structures for 6-lane freeway (two bridges now under construction on this section of Bakersfield Bypass)	5.7	7,500,000
Kern	US 99	0.8 mile south of Sherwood Ave. to 0.4 mile south of Pond Rd. in and near McFarland; grade, pave and structures to convert from expressway to 4-lane freeway	3.4	1,500,000
Kern	HR 142	Woody to Greenhorn Summit (portions); grade and pave to widen		50,000
Kern	US 466	0.1 mile east of Caliente Rd. to 0.5 mile east of Keene; grade, pave and structures for 4-lane freeway	5.7	4,750,000
Kern	FAS 882	H St. between Brundage Lane and Truxtun Ave. in Bakersfield; grade and surface to widen to 4 lanes (urban extension of FAS County Rd.; city's share, $94,150)	1.3	94,150 (State's share)
Kern	FAS 887	Union Ave. between Irene St. and Panorama Dr. north of Bakersfield; grade and surface for 6-lane divided highway (urban extension of FAS County Rd.; city's share, $77,500)	0.8	77,500 (State's share)
Kern	Various	Rights of way including $1,895,000 on US 99 in Bakersfield area		3,910,000
Kings	Various	Rights of way including $444,000 on SR 198 in Lemoore-Hanford area		492,000
Lake	SR 53	0.4 mile south of Harris Creek to Lower Lake; grade and pave to construct 2-lane access controlled highway (eliminates last substandard section between Napa County line and Sign Route 20, a distance of 28 miles)	4.7	900,000
Lake	Various	Rights of way		50,000
Lassen	Various	Rights of way		120,000
Los Angeles	US 101	Ventura Freeway—Hollywood Freeway to Reseda Blvd. (portions); median barrier	2.4	55,000
Los Angeles	US 101	Hollywood Freeway—Benton Way to Ventura Freeway (portions); median barrier	6.3	318,000
Los Angeles	US 101	Ventura Freeway—0.5 mile east to 0.5 mile west of Las Virgenes Rd. west of Calabasas; interchange structure, approaches and frontage roads	1.0	380,000
Los Angeles	HR 2	Whittier Blvd.—Santa Gertrudes Ave.-Russell St. to Washington Blvd. in Whittier; traffic signal modifications at 13 intersections (Co-operative project—city's share, approximately $80,000)		90,000 (State's share)
Los Angeles	HR 2	Whittier Blvd.—Atlantic Blvd. to Downey Rd.; lighting, channelization and traffic signal modifications at 8 intersections (Co-operative project—Los Angeles county's share about $37,000)		60,000 (State's share)
Los Angeles	US 99	Golden State Freeway—Cypress Ave. to Roscoe Blvd.; landscape	3.5	180,000
Los Angeles	US 99	Golden State Freeway—Roscoe Blvd. to Lankershim Blvd.; landscape	1.7	110,000
Los Angeles	US 6, 99	Golden State Freeway—Glendale Blvd. to Burbank Blvd. in Burbank; median barrier	6.1	143,000
Los Angeles	US 6, 99	Golden State Freeway—0.1 mile west of Lankershim Blvd. to Osborne St. near Sun Valley; grade, pave and structures for 8-lane freeway (together with other current projects, will complete east-loop bypass portion of Golden State Freeway between the Santa Ana Freeway southeast of Los Angeles civic center and US 6 north of San Fernando, a distance of 29 miles)	2.4	6,200,000
Los Angeles	US 66	Foothill Blvd.—0.1 mile west of Mountain Ave. in Monrovia to Georgia Ave. in Azusa (portions); widen to 4-lane divided and modify traffic signals	3.2	200,000

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County	Route†	Description	Approx. mileage	Estimated cost
Los Angeles	US 6	Antelope Valley Freeway—Sierra Highway at Soledad Canyon Rd. to Sierra Highway at Red Rover Mine Rd. southwest of Palmdale; grade, pave and structures for 4-lane freeway. (Grading in progress on a portion of this stretch under current contract)	16.0	8,000,000
Los Angeles	US 60, 70, 99	San Bernardino Freeway—Arroyo Ave. in West Covina to Puente Ave. in Baldwin Park; median barrier	9.5	220,000
Los Angeles, San Bernardino	US 70, 99	San Bernardino Freeway—0.1 mile west of Los Angeles County line to 0.6 mile east of Vineyard Ave. near Ontario; grade, pave and structures to widen to 6 lanes	6.8	950,000
Los Angeles	US 60, 70, 99	San Bernardino Freeway—At Orange Ave.-Pacific Ave. and Sunset Ave.-Irwindale Ave. Interchanges in West Covina; landscape		65,000
Los Angeles	US 60, 70, 99	San Bernardino Freeway—Evergreen Ave. in Los Angeles to 0.1 mile east of Long Beach Freeway in Monterey Park (portions); median barrier	2.0	115,000
Los Angeles	US 60, 70, 99	San Bernardino Freeway—Long Beach Freeway in Monterey Park to Wescott Ave. in Baldwin Park (portions); landscape		375,000
Los Angeles	US 101 Alt.	Pacific Coast Highway—0.1 mile east to 0.3 mile east of Sunset Blvd.; embankment protection work	0.2	200,000
Los Angeles	SR 2	Angeles Crest Highway—La Canada Bridge to Angeles Forest Highway in Pasadena (portions); grade and pave to construct passing lanes	1.0	75,000
Los Angeles	SR 39	San Gabriel Canyon Rd—North city limit of Azusa to end of constructed road near Crystal Lake (portions); grade, pave and structures for widening and realignment	1.6	750,000
Los Angeles	SR 39	San Gabriel Canyon Rd.—West Fork of San Gabriel River Bridge; replace bridge and construct approaches		150,000
Los Angeles	HR 77	Valley Blvd.—Mission Dr. in Rosemead to Cabrillo Ave. in Alhambra; traffic signal modifications at 27 intersections. (Co-operative project—Local agencies' share, $41,000)		45,000 (State's share)
Los Angeles	HR 158	San Diego Freeway—California Ave. in Signal Hill to Long Beach Freeway near Long Beach; grade, pave and structures for 8-lane freeway	1.8	8,000,000
Los Angeles	HR 158	San Diego Freeway—174th St. (SR 14) in Torrance to 0.3 mile west of Hawthorne Ave. (SR 107) in Lawndale; grade, pave and structures for 8-lane freeway	1.2	3,400,000
Los Angeles	HR 158	San Diego Freeway—Hawthorne Ave. (SR 107) in Lawndale to 135th St. in Hawthorne; grade, pave and structures for 8-lane freeway	2.1	4,000,000
Los Angeles	HR 158	San Diego Freeway—0.1 mile south of 135th St. in Hawthorne to Lennox Blvd. in Los Angeles; grade, pave and structures for 8-lane freeway	2.1	5,600,000
Los Angeles	HR 158	San Diego Freeway—0.1 mile south of Lennox Blvd. to 0.2 mile northwest of La Tijera Blvd. near Inglewood; grade, pave and structures for 8-lane freeway	2.9	$7,300,000
Los Angeles	HR 158	San Diego Freeway—La Tijera Blvd. to 0.4 mile north of Jefferson Blvd.; grade, pave and structures for 8-lane freeway (this project and five previously listed, along with other current and budgeted work, will complete the San Diego Freeway from California Ave. at Signal Hill to Burbank Blvd. north of the Ventura Freeway, a distance of about 35 miles)	1.8	4,300,000
Los Angeles	SR 7	San Diego Freeway—Venice Blvd. to Wilshire Blvd. in Los Angeles; median barrier	3.6	84,000
Los Angeles	SR 134	Ventura Freeway—Hollywood Freeway to Buena Vista St. in Burbank; grade, pave and structures for 8-lane freeway (together with current freeway project to the east, this will complete Ventura Freeway between Golden State and Hollywood Freeways)	3.0	7,700,000
Los Angeles	US 6, 101	Harbor Freeway—124th St. to 4-level interchange; and Santa Ana Freeway—Rosecrans Ave. to Lakewood Blvd. and Alameda St. to 4-level interchange; median barrier	14.7	503,000
Los Angeles	SR 35	Norwalk Blvd.—0.2 mile south of Lakeland Rd. in Norwalk to Washington Blvd. near Santa Fe Springs; widen to 4 lanes and install traffic signals (Cooperative project—local agencies' share, $50,000)	3.0	325,000 (State's share)
Los Angeles	SR 35	Workman Mill Rd. to San Gabriel River Parkway; grade, pave and structures; re-routing the highway through a railroad underpass to eliminate a crossing at grade and construction of the Peck Rd. Interchange on the route of future San Gabriel River Freeway)	1.3	800,000
Los Angeles	SR 26	Olympic Blvd. in Beverly Hills area—Centinela Ave. in Los Angeles to Los Angeles St.; traffic signal modifications at 67 intersections. (Cooperative project—Local agencies' share, $78,000)		81,000 (State's share)
Los Angeles	SR 26	Santa Monica Freeway—Lincoln Blvd. in Santa Monica to Sawtelle Blvd. in Los Angeles (portions); structures for future 8-lane freeway		2,000,000
Los Angeles	SR 26	Santa Monica Freeway—0.1 mile west of Sawtelle Blvd. to 0.2 mile east of Overland Ave. in Los Angeles (portions); structures for future 8-lane freeway		3,300,000
Los Angeles	SR 26	Santa Monica Freeway—0.4 mile west to 0.2 mile east of Motor Ave. (portions); structures and embankment for railroad relocation		900,000
Los Angeles	SR 26	Santa Monica Freeway—Motor Ave. to 0.2 mile east; construct retaining wall		60,000
Los Angeles	SR 26	Santa Monica Freeway—0.1 mile west of Fairfax Ave. to Hoover St. (portions); grade, pave and structures for future freeway (short section of freeway and structures)	0.4	3,600,000
Los Angeles	SR 26, US 101 US 99	At East Los Angeles Interchange; landscape		395,000
Los Angeles, Orange	US 101	Santa Ana Freeway—Rosecrans Ave. in Norwalk to Magnolia Ave. in Anaheim; median barrier	5.1	278,000
Los Angeles	SR 14	Artesia St.—Long Beach Blvd. in Long Beach to Downey Ave. in Bellflower; traffic signal modifications at 9 intersections (Cooperative project—local agencies' share, $51,000)		55,000 (State's share)

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County	Route†	Description	Approx. mileage	Estimated cost
Los Angeles	Various	Rights of way including $4,000,000 on Foothill Freeway between Arcadia and Glendora, $10,000,000 on San Gabriel River Freeway, $8,800,000 on Pomona Freeway and $18,000,000 on Santa Monica Freeway		55,233,000
Madera	SR 152	Ash Slough Bridge west of Califa; replace bridge and construct approaches	0.7	300,000
Madera	SR 41	Deadwood Creek Bridge near Coarsegold; replace bridge with culvert		23,000
Madera	Various	Rights of way		350,000
Marin	US 101	Vista Point at Golden Gate Bridge; grade and pave parking area and landscape		200,000
Marin	US 101	North end of Golden Gate Bridge to 0.1 mile south of Waldo Tunnel; median barrier	0.8	175,000
Marin	US 101	Auburn St. Railroad Crossing; reconstruct undercrossing on Auburn St. and grade and pave frontage roads along US 101 south of San Rafael	0.4	85,000
Marin	US 101	0.1 mile south of Waldo Undercrossing to 0.2 mile north of Freitas Parkway (portions); landscaping in Corte Madera, Larkspur, and San Rafael		80,000
Marin	US 101	Gallinas Creek north of San Rafael; bridge widening and channel lining		125,000
Marin, Sonoma	US 101	Atherton Ave. north of Novato to Petaluma Creek (portions); drainage facilities and resurfacing		135,000
Marin	HR 52	0.4 mile east of Strawberry Drive to US 101 at Alto; grade and pave to widen to 4-lanes divided	0.9	400,000
Marin	SR 1	Stinson Beach to Bolinas Rd. (portions); drainage facilities and resurfacing		100,000
Marin	Various	Rights of way including $1,075,000 for US 101 freeway north of San Rafael		1,225,000
Mariposa, Tuolumne	SR 120	0.1 mile west to 0.1 mile east of Mariposa-Tuolumne County line; grade and pave to reconstruct, widen, and realign for initial 2 lanes of future 4-lane expressway	2.3	$450,000
Mariposa	SR 49	Bear Valley to Coulterville (portions); grade and pave to reconstruct and widen	4.0	100,000
Mariposa	Various	Rights of way		105,000
Mendocino	US 101	Ford Rd. to 0.5 mile south of Forsythe Creek north of Ukiah (portions); structures and approaches for first unit of future 4-lane freeway		1,750,000
Mendocino	SR 1 & SR 20	Fort Bragg to Willits on SR 20 and Westport to Leggett on SR 1; replace culverts at various locations		60,000
Mendocino	SR 1	Glennan Gulch north of Gualala; reconstruction and culvert	0.8	260,000
Mendocino	SR 1	Henry Gulch; reconstruct and culvert	0.4	85,000
Mendocino	Various	Rights of way including $910,000 for future US 101 freeway in vicinity of Ukiah		1,200,000
Merced	Various	Rights of way		590,000
Modoc	Various	Rights of way		50,000
Mono	US 395	Through Bridgeport; grade, pave and structures for reconstruction and drainage improvement	0.7	170,000
Mono	SR 89	Alpine County line to US 395; drainage facilities and resurfacing	8.0	250,000
Mono	Various	Rights of way		105,000
Monterey	US 101	Camphora Overcrossing to 1.4 miles south of Gonzales; functional planting	4.0	50,000
Monterey	US 101	2.2 miles south to 2.3 miles north of Gonzales; grade, pave and structures for 4-lane freeway. (Closes last gap in 46 miles of continuous freeway and expressway between King City and Salinas)	6.1	2,450,000
Monterey	SR 1	Villa Creek Bridge about 7 miles north of San Luis Obispo County line; new bridge and approaches	0.2	370,000
Monterey	SR 1	Fremont St. in Monterey to Fort Ord; grade, pave and structures for 4-lane freeway	3.7	6,800,000
Monterey	Various	Rights of way		1,035,000
Napa	SR 12, 37, 29	0.5 mile south of Imola Ave. to 0.1 mile north of Old Sonoma Rd. at Napa; grade, pave and structures for 4-lane freeway (Cooperative project—County's share $60,090)	1.0	970,000 (State's share)
Napa	Various	Rights of way		460,000
Nevada, Placer	SR 49	Bear River Bridge north of Auburn; replace bridge and construct approaches	0.8	300,000
Nevada	SR 49	1.5 miles north of South Fork Yuba River to North San Juan (portions); grade and pave to realign		50,000
Nevada	US 40	0.5 mile west to 2.6 miles east of Soda Springs; structures and grading for future Donner Summit freeway. (Second of three units required to complete freeway; first unit under construction)	3.7	2,700,000
Nevada	Various	Rights of way including $435,000 for SR 20 between Yuba County line and Grass Valley		765,000
Orange	US 101	San Diego Freeway-Avenida Allessandro in San Clemente to 1.5 miles north of US 101 Alt. and US 101 Atl. connection; functional planting	7.1	152,000
Orange	US 101	San Diego Freeway—4.3 miles south of Niguel Rd. near El Toro; truck scales		210,000
Orange	US 101	Santa Ana Freeway—Magnolia Ave. to South St. in vicinity of Anaheim and Fullerton; median barrier	3.7	160,000
Orange, Los Angeles	US 101	Santa Ana Freeway—Rosecrans Ave. in Norwalk to Magnolia Ave. in Anaheim; median barrier	5.1	278,000
Orange	US 101, SR 22	Santa Ana, Garden Grove, and Route 19 Interchange in and near Orange and Santa Ana; grade, pave and structures on Santa Ana Freeway from 0.2 mile north of Santa Ana River to 0.1 mile south of Santiago Creek, and on Garden Grove Freeway from 0.2 mile west of Placentia Ave. to 0.3 mile east of Main St. (Project will provide interchange at future freeway junction)	3.2	13,700,000
Orange	US 91	Riverside Freeway—Lemon St. to east of Placentia Ave. in Fullerton and Anaheim; landscape	2.1	64,000
Orange	HR 176	Route 176 Freeway—Yorba Linda Rd. to Orangethorpe Ave. near Yorba Linda; grade, pave and structures to construct initial 2 lanes of future 4-lane freeway	2.3	1,360,000
Orange	SR 22	Garden Grove Blvd.—Century Blvd. to Harbor Blvd. in Garden Grove; grade and pave to widen to 4 lanes and install lighting and traffic signals (Cooperative project—Garden Grove's share, $10,000)	1.5	250,000 (State's share)

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County	Route†	Description	Approx. mileage	Estimated cost
Orange	FAS 742	Harbor Blvd. between Westminster Ave. and Chapman Ave. in Garden Grove; grade and surface to widen to 4 lanes divided (urban extension of FAS County Rd.; city's share, $250,000)	2.2	250,000 (State's share)
Orange	Various	Rights of way including $1,000,000 on Rte. 19 Freeway and $3,000,000 on Garden Grove Freeway		6,100,000
Placer	US 40	East Roseville Overcrossing to east of Penryn Rd. Overcrossing; functional planting	7.5	40,000
Placer	US 40	0.2 mile south to 0.2 mile north of Colfax-Grass Valley Highway; landscaping	0.4	5,000
Placer	SR 28	Top of Dollar Grade to Nevada State line near Brockway; grade and pave to widen	8.1	1,200,000
Placer, Nevada	SR 49	Bear River Bridge north of Auburn; replace bridge and construct approaches	0.8	300,000
Placer	Various	Rights of way		345,000
Plumas	SR 89	2 miles north of Canyon Dam to 1.3 miles north of Almanor Inn; grade and pave for 2-lane access controlled highway	6.5	665,000
Plumas	Various	Rights of way		15,000
Riverside	US 60	Sunnyslope to Orange St. in Riverside; grade, pave and structures for 4-lane freeway	5.7	5,530,000
Riverside	US 60, 70, 99	At Twentynine Palms Highway about 2 miles east of Whitewater; structure and approaches for interchange	1.3	1,150,000
Riverside	US 91, 395	Riverside Freeway—0.3 mile south of Arlington Ave. to San Bernardino County line (portions); landscape	2.7	150,000
Riverside	SR 74	West boundary of San Bernardino National Forest to Keene Camp (portions); grade and pave for widening and curve improvement	0.4	35,000
Riverside	US 395	At SR 74 about 3 miles southeast of Perris; structure and approaches for Ethanac Overhead and Interchange	1.0	900,000
Riverside	SR 74	Grand Ave. to Adam Ave. about 1.0 mile west of Elsinore (portions); grade and pave for widening and some realignment	3.1	100,000
Riverside	SR 111	0.6 mile west of Chino Creek to San Rafael Dr. in Palm Springs; grade and pave to construct 4-lane expressway	0.9	210,000
Riverside	SR 111	0.3 mile west of Indio west city limit to Arabia St.; grade and pave for widening and channelization	0.9	57,000
Riverside	Various	Rights of way		1,900,000
Sacramento	US 40	On 16th, 29th and 30th Sts.; curb and gutter corrections		75,000
Sacramento	US 40	Capitol Mall—4th St. to 10th St.; grade and pave for widening to provide for center landscaping and turn lanes	0.5	550,000
Sacramento	Various	Rights of way including $3,030,000 for east-west and north-south freeways in Sacramento, and $1,400,000 for US 50 freeway east of Sacramento		4,830,000
San Benito	SR 156	0.5 mile east of San Juan Bautista to 0.4 mile west of the San Benito River; grade and pave to construct initial 2 lanes of future 4 lane expressway	5.1	530,000
San Benito	Various	Rights of way		350,000
San Bernardino, Los Angeles	US 70, 99	San Bernardino Freeway—0.1 mile west of Los Angeles County line to 0.6 mile east of Vineyard Ave. near Ontario; grade, pave and structures to widen to 6 lanes	6.8	950,000
San Bernardino	US 70, 99	At 16th St. about 2 miles east of Redlands; structures and approaches for 16th St. Overcrossing		250,000
San Bernardino	US 66, 91	Barstow Freeway—Mojave Drive Interchange in Victorville; grade, pave and structure to construct interchange	0.6	380,000
San Bernardino	US 91, 466	1.0 mile east of Cima Rd. to Nevada line; grade, pave and structures for additional 2 lanes to provide 4-lane freeway (Connects with similar 25-mile freeway project now in progress to the west)	23.2	7,000,000
San Bernardino	US 66, 91, 395	Court St. to 0.4 mile north of 27th St. in San Bernardino; landscape	3.1	235,000
San Bernardino	SR 30	Big Bear Dam to 1.2 miles east; grade and pave to widen	1.2	80,000
San Bernardino	SR 18, 30	1.5 miles east of Lakeview Point to Big Bear Dam (portions); grade and pave to widen to 4 lanes	2.0	500,000
San Bernardino	SR 18	1.0 mile east of Victorville to US 91-66; grade, pave and structures for 4-lane highway and 4-lane expressway	2.7	1,150,000
San Bernardino	US 66	16 miles west of Amboy to 26 miles west of Needles (portions); reconstruct shoulders and resurface		700,000
San Bernardino	SR 30	7.0 to 6.4 miles southwest of Running Springs; grade and pave for passing lanes	0.5	100,000
San Bernardino	FAS 712	Waterman Ave. between Dumas St. and Mill St. southeast of San Bernardino; grade and surface for 4-lane divided highway (urban extension of FAS County Rd.; county's share, $181,000)	1.0	181,000 (State's share)
San Bernardino	Various	Rights of way		3,801,000
San Diego	US 101	0.1 mile north to 0.5 mile north of south city limit of National City; grading (construct fill for interchange)	0.4	300,000
San Diego	US 101	Division St. to Market St. (portions); grading, paving and structures on future north-south freeway route (crossing and interchange structures and approaches)	3.2	6,600,000
San Diego	US 101	0.1 mile south of Sorrento Rd. to 0.5 mile north of Skyline Dr. in and north of San Diego (portions); grading (construct fill for future freeway)	4.2	2,500,000
San Diego	US 80	Chase Ave. to Flume Dr. in and near El Cajon (portions); resurface existing highway including some widening		150,000
San Diego	SR 78	1.0 mile west of Vista to Rancho Santa Fe Rd.; grade, pave and structures for 4-lane freeway. (Connects with 5.4 miles of 4-lane expressway now under construction to the east)	5.1	4,200,000
San Diego	SR 94	Granada Ave. to Avocado Blvd. near Spring Valley; grade and pave to widen	1.1	80,000
San Diego	SR 94	Merritt Dr. to Rogers Rd. near Spring Valley; grade and pave to widen	0.8	80,000

† Numbers marked SR are State Sign Routes; numbers marked US are US Highway routes; numbers not marked are legislative routes.

County	Route†	Description	Approx. mileage	Estimated cost
San Diego	Various	Rights of way including $6,200,000 for US 101 freeway in National City and San Diego, $2,500,000 for US 101 freeway between Del Mar and Carlshad, $1,500,000 on US 80 in and east of El Cajon, $1,000,000 on SR 67 in and north of El Cajon, and .800,000 on SR 94 in Spring Valley area		13,960,000
San Francisco	US 101	Golden Gate Ave. to Lombard St. in San Francisco; resurfacing Van Ness Ave.	1.5	150,000
San Francisco	US 101	Southern Freeway—Orizaba Ave. to 0.4 mile north of Ocean Ave.; grade, pave and structures for 6-lane freeway	1.8	4,600,000
San Francisco	HR 263	Southern Freeway Extension—James Lick (Bayshore) Freeway to 3 blocks north of Oakdale Ave.; grade, pave and structures for 6-lane freeway (city to buy rights of way)	0.7	5,600,000
San Francisco	Various	Rights of way		1,905,000
San Joaquin	US 99	2.5 miles south of Lodi to 1.0 mile north of Mokelumne River; grade, pave and structures for 4-lane freeway (Lodi Bypass)	5.2	3,000,000
San Joaquin	Various	Rights of way including $800,000 for Tracy Bypass on Interstate 5W		2,040,000
San Luis Obispo	US 101	Through Arroyo Grande; landscape	1.4	50,000
San Luis Obispo	US 101	Pismo Beach Overhead to 0.3 mile north of North Pismo Separation; landscape	1.9	80,000
San Luis Obispo	US 101	Los Osos Road Interchange, 1.5 miles south of San Luis Obispo; grade, pave and structure for interchange	0.8	460,000
San Luis Obispo	SR 166	US 101 to 0.9 mile west of Huasna River; grade and pave to construct access-controlled 2-lane highway	6.6	1,300,000
San Luis Obispo	US 466	0.1 mile west of San Gabriel Rd. in Atascadero to US 101; grade and pave to widen and reconstruct	1.8	290,000
San Luis Obispo	HR 125	Highway Route 137 to 1.0 mile east of Huer Huero Creek near Creston; grade, pave and structures for new Huer Huero Creek Bridge and approaches	1.1	230,000
San Luis Obispo	Various	Rights of way		1,605,000
San Mateo	US 101	Taylor Blvd. to Santa Helena Ave. in Millbrae; grade and pave to reconstruct	0.8	245,000
San Mateo	SR 1	Tunitas Creek Bridge south of Half Moon Bay; replace bridge and construct approaches	1.0	550,000
San Mateo	US 101 Byp.	Bayshore Freeway—0.1 mile south of Spruce Ave. in Redwood City to 0.1 mile north of University Ave. in Menlo Park (portions); landscape	4.1	150,000
San Mateo, Santa Clara	US 101 Byp.	Bayshore Freeway—0.1 mile south of University Ave. to Matadero Creek in and near Palo Alto; landscape	1.9	175,000
San Mateo	HR 105	West Hillsdale Blvd. Extension to San Mateo-Hayward Bridge (19th Ave. Freeway); grade, pave and structures for 6-lane freeway (freeway construction from West Hillsdale Blvd. Extension to S. Delaware St.; grading only from S. Delaware St. to bridge)	4.9	4,800,000
San Mateo, Santa Cruz	SR 1	Davenport to Princeton (portions); base and resurface		210,000
San Mateo	Various	Rights of way including $3,600,000 for Junipero Serra Freeway; $900,000 for SR 1 freeway through Pacifica; and $1,200,000 for HR 214 from Five Points in Redwood City to Bayshore Freeway at Harbor Blvd.		7,515,000
Santa Barbara	US 101	0.2 mile east of Bath St. to 0.6 mile west of Los Olivos St. in Santa Barbara; grade, pave and structures for 4-lane freeway	2.5	4,600,000
Santa Barbara	US 101	Winchester Creek to 0.2 mile west of Las Varas Creek west of Santa Barbara; functional planting	3.9	66,000
Santa Barbara	US 101	0.6 mile west of Refugio to 0.4 mile west of Tajiguas; functional planting	2.1	$35,000
Santa Barbara	HR 2	Orcutt Highway—Norris St. in Orcutt to Mooncrest Lane; functional planting	0.9	12,000
Santa Barbara	HR 150	Cliff Drive—La Marina in Santa Barbara to US 101 at Las Positas; grade and pave to construct 4-lane and 2-lane highway	3.6	950,000
Santa Barbara	HR 236	Ward Memorial Freeway—Goleta Campus of University of California to US 101 near Goleta; grade, pave and structures for 4-lane freeway	2.6	2,850,000
Santa Barbara	Various	Rights of way		1,480,000
Santa Clara	US 101	El Camino Real—Matadero Creek to University Ave. in Palo Alto; grade and pave to widen from four to six lanes	2.7	850,000 (State's share)
Santa Clara	US 101	Madrone Underpass in Morgan Hill to Metcalf Rd. near San Jose; resurface	8.0	220,000
Santa Clara	SR 17, US 101 Bypass	Nimitz Freeway—between Bascom Ave. and 0.6 mile north of Bayshore Highway; and Bayshore Freeway—between 0.3 mile west of Brokaw Rd. and Coyote Creek in and near San Jose; landscape at Bayshore-Nimitz Freeway Interchange	6.0	300,000
Santa Clara	SR 152	Highway Route 22 near San Felipe to Bell's Station (portions); drainage facilities and resurfacing	5.0	200,000
Santa Clara	SR 6	Saratoga Gap to 3.1 miles north; reconstruct shoulders and resurface	3.1	90,000
Santa Clara, San Mateo	US 101 Byp.	Bayshore Freeway—0.1 mile south of University Ave. to Matadero Creek in and near Palo Alto; landscape	1.9	175,000
Santa Clara	US 101 Byp.	Tully Rd. Interchange south of San Jose; grade, pave and structure for interchange		860,000
Santa Clara	SR 9	0.2 mile east of San Jose-Alviso Rd. in Alviso to Nimitz Freeway; grade and pave to widen and realign and construction of new Coyote Creek Bridge	2.3	360,000
Santa Clara	FAS 998	Curtner and Stone Aves. between the Southern Pacific railroad and US 101; grade, surface and structure for 4-lane divided highway. (Urban extension of FAS County Rd.; county's share, $230,500)	0.8	230,500 (State's share
Santa Clara	Various	Rights of way including $2,360,000 for Junipero Serra Freeway		4,690,000
Santa Cruz	SR 1	41st Ave. Interchange south of Santa Cruz; grade, pave and structure for interchange	1.5	580,000
Santa Cruz, San Mateo	SR 1	Davenport to Princeton (portions); base and resurface		210,000
Santa Cruz	HR 67	Chittenden Pass Rd.—1.9 to 3.5 miles east of Watsonville; grade and pave to realign	1.0	250,000

† Numbers marked SR are State Sign Routes; numbers marked US are US Highway routes; numbers not marked are legislative routes.

County	Route†	Description	Approx. mileage	Estimated cost
Santa Cruz	Various	Rights of way		435,000
Shasta	US 99	Cottonwood to 0.1 mile north of Bruce Dr. in Anderson; grade and pave for 4-lane freeway by constructing 2 additional lanes	3.8	725,000
Shasta	Various	Rights of way including $1,500,000 for future US 99 Freeway from between south of Anderson and north of Redding		2,430,000
Sierra	SR 49	0.2 mile east of North Fork of Yuba River to 0.25 mile east of Ramshorn Creek (portions); pave previously graded sections	3.1	130,000
Sierra	SR 49	Bassetts to Yuba Pass (portions); grade and pave to widen		50,000
Sierra	SR 49	Between Sierraville and Loyalton (portions); reconstruct base and resurface		100,000
Sierra	Various	Rights of way		140,000
Siskiyou	SR 89	McCloud to junction with US 99; grade and pave for 2-lane access-controlled highway	10.4	1,440,000
Siskiyou	Various	Rights of way		420,000
Solano	US 40	1.9 miles southwest of Vacaville to 1.2 miles northeast of Vacaville-Dunnigan Cutoff; grade, pave and structures to convert from expressway to six-lane freeway	5.1	5,400,000
Solano	Various	Rights of way		1,025,000
Sonoma	US 101	Lytton to Cloverdale (portions); grade and pave to reconstruct		200,000
Sonoma, Marin	US 101	Atherton Ave. north of Novato to Petaluma Creek (portions); drainage facilities and resurfacing		135,000
Sonoma	SR 1	7.6 miles to 8.1 miles north of Jenner; grade and pave to reconstruct	0.5	150,000
Sonoma	SR 12	0.3 mile west of Duncans Mills west of Monte Rio to 0.3 mile east of Austin Creek; grade, pave and structures for realignment	1.9	600,000
Sonoma	Various	Rights of way including $1,300,000 for US 101 freeway in and north of Santa Rosa, and $1,930,000 for SR 12 between Sebastopol and Kenwood		3,870,000
Stanislaus	US 99	1.6 miles south of Modesto (Hatch Rd.) to 2.4 miles north of Modesto (Shoemake Ave.); grading and structures for future 6-lane freeway through Modesto	5.7	6,800,000
Stanislaus	SR 33	Through Patterson; grade and pave to widen to 4 lanes	1.2	150,000 (State's share)
Stanislaus	Various	Rights of way		1,100,000
Sutter	SR 24	0.2 mile south of Cornelius Ave. to Rio Oso; grade and pave to reconstruct and realign	2.7	500,000
Sutter	Various	Rights of way		440,000
Tehama	US 99	0.2 mile north of Red Bluff to Shasta County line; grade, pave and structures to provide 4-lane freeway by constructing additional 2 lanes	12.2	5,100,000
Tehama	SR 36	0.3 mile west of Palmer Gulch to 0.1 mile east of Dales (portions); bridge replacements and approaches at DeHaven, Sheep, Supan and Palmer Gulches northeast of Red Bluff	1.6	327,000
Tehama	Various	Rights of way		210,000
Tulare	FAS 1142	El Monte Way, between east Tulare St. and Crawford Ave. in Dinuba; grade and surface to construct 4-lane highway (urban extension of FAS County Rd.; Dinuba's share, $33,350)	0.4	33,350 (State's share)
Tulare	Various	Rights of way including $3,087,000 on SR 198 in Visalia area		3,734,000
Tuolumne	SR 108	6.5 miles east of Sonora to 0.8 mile east of Hunts Camp; grade and pave for 4-lane expressway on Twain Harte Grade	3.5	1,150,000
Tuolumne, Mariposa	SR 120	0.1 mile west to 0.1 mile east of Mariposa-Tuolumne County line; grade and pave to reconstruct, widen and realign for initial 2 lanes of future 4-lane expressway	2.3	450,000
Tuolumne	Various	Rights of way		470,000
Ventura	US 101, SR 23	Ventura Freeway—0.5 mile east to 0.5 mile west of Moorpark Rd., and on Moorpark Rd. (SR 23) from Ventura Freeway to Olson Rd. near Newbury Park; grade, pave and structures to provide interchange on Ventura Freeway and 4-lane divided highway on Moorpark Rd.	4.5	1,340,000
Ventura	US 101	Ventura Freeway—Borchard Road Interchange and frontage roads between 0.4 mile east and 0.5 mile west of Borchard Rd. west of Newbury Park; grade, pave and structure for interchange	0.9	550,000
Ventura	SR 126	US 101 at Ventura to 0.1 mile east of SR 118; grade, pave and structures for 4-lane freeway	5.5	3,500,000
Ventura	HR 153, US 101 Alt.	Hueneme and Saviers Rds.—Fourth St., in Port Hueneme to US 101 Alt., and on US 101 Alt. from Saviers Rd. to 0.2 mile southeast; grade, pave, structures, signals and channelization (mainly widening to 4 lanes on Hueneme and Saviers Rds.)	4.1	835,000
Ventura	SR 23	Triunfo Creek Bridge on Decker Rd. south of US 101; replace bridge and construct approaches	0.2	75,000
Ventura	Various	Rights of way including $1,000,000 for SR 126 freeway		3,157,000
Yolo	US 40	Richards Blvd. Interchange at Davis; landscaping		100,000
Yolo, Colusa	SR 45	3.5 miles south to 4.5 miles north of Yolo-Colusa County line; grade and pave for reconstruction and widening with some realignment	8.0	700,000
Yolo	SR 16	Rumsey to Esparto (portions); widen three bridges		95,000
Yolo	HR 90	6.8 miles north of Madison to US 99W on Dunnigan-Vacaville Cutoff; reinforce base and resurface	5.6	127,000
Yolo	Various	Rights of way		500,000
Yuba	US 99E	Power Line Rd. in Olivehurst to Yuba River; functional planting	3.5	19,000
Yuba	US 99E	Yuba River to Second St. in Marysville; landscaping at new Yuba River Bridge		20,000
Yuba	SR 20	Dry Creek to Parks Bar Bridge east of Marysville; grade and pave to reconstruct and widen	4.0	190,000
Yuba	Various	Rights of way		20,000

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PHOTO ABOVE—Now open to traffic is the new freeway bypass on U.S. Highway 101 at Healdsburg. This photograph, taken while construction was in progress, shows the previously completed Russian River Bridge and the bypass route (left) west of the city. PHOTO BELOW—Landscaping on a section of the Nimitz Freeway (Sign Route 17) in Oakland. In planning landscaping on metropolitan area freeways, Division of Highways landscape architects must select trees and shrubs which present a pleasing appearance, require low cost maintenance, and also serve functional purposes such as erosion control and the screening of headlight glare and traffic noise.



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CALIFORNIA Highways and Public Works

MAR 8 1961



JANUARY-FEBRUARY 1961

The Pasadena Freeway—And Others

"The Freeway System Is a Persuasive Example of the Need for Adequate Metropolitan Planning"

(Reprinted from the Los Angeles *Times* editorial page, Dec. 31, 1960)

People who drive the Pasadena Freeway probably never give a thought to its age; they may even think it has been there as long as the Arroyo Seco, which parallels it for about five miles.

Yet the Pasadena Freeway (it used to be called the Arroyo Seco Parkway) is only 20 years old, and the pretty Rose Queen who cut the ceremonial ribbon in December, 1940, participated in the anniversary celebration the other day looking hardly a year older.

The Pasadena was the first of the freeways, the prototype of the Southern California system. It was a compromise of plans and counterplans; it has bends in it that would get a present-day highway engineer burned for heresy; and withal—as its 70,000 daily drivers will testify—it still is the pleasantest short freeway haul of the developing system. One of the reasons that it is almost ulcer-proof, despite the flowing script of its reverse curves, is that the great trucks have been rigorously excluded from it. Its access roads belong to a more innocent era, when cruising speeds were farther from the sound barrier, but the Pasadena Freeway has risen above its disabilities and serves its 70,000 daily cars almost as well as the 27,000 it was designed for.

Neil S. Petree remarked at the anniversary celebration that another 20 years of freeway development lies ahead. The system presumably will catch up with the population 40 years after the bank of the arroyo was paved.

If this remark feeds the fires of impatience, it should not. For it is quite likely that the first 20 years of freeway building were the most trying, and that the improvements from now on will be fast and striking. Within five years there will be some operating additions to the network which will radically change the traffic patterns of the metropolitan area—and for the better.

Critics of the system have been premature and unjust. They began to find fault with the system before it was a system. They could prove to anyone who would listen that the Hollywood Freeway's regular jams showed the freeway plan would not work. This was like complaining of a new power plant's capacity before all the generators were installed. The wonder is that the Hollywood Freeway has served so well.

Within the next year the loop of the Golden State Freeway will be in operation, crossing the Pasadena, San Bernardino and Santa Ana Freeways and ending at the Harbor Freeway until it is continued to Santa Monica. The effect of this loop on the Hollywood Freeway may be startling. The truck traffic which has plagued it will mostly flow naturally into the other route and the traffic through the central city will ease.

Much has been said about the need for adequate planning for the metropolitan area. The freeway system, it seems to us, is a persuasive example of the usefulness of such planning. The critics forgot that the grander the plan the longer the period of execution. The freeway system could not have been put together instantly even if the funds (it is a pay-as-you-go project) were always available, although the Southern California network might be several years ahead of its present schedule if there had always been enough money.

It will never be a perfect system—what system is? But it will be an achievement of much forethought by government agencies and groups from the state to the neighborhood level. It would be folly to scrap the grand plan now with the argument that the inadequacy of the parts precludes the adequacy of the whole.

If that argument were acceptable, all metropolitan planning would be futile. Worse than that, planning would make chaos more chaotic, because the critics of a plan usually have another plan to impose on the one they are rejecting, like those birds that return annually to build a new nest on last season's rickety remains.

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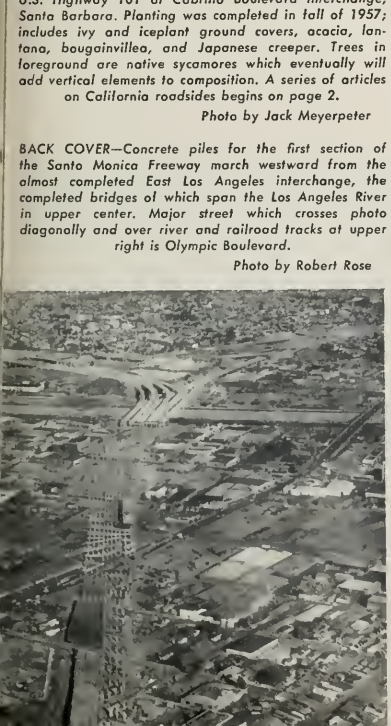


FRONT COVER—Example of highway landscaping on U.S. Highway 101 at Cabrillo Boulevard interchange, Santa Barbara. Planting was completed in fall of 1957; includes ivy and iceplant ground covers, acacia, lantana, bougainvillea, and Japanese creeper. Trees in foreground are native sycamores which eventually will add vertical elements to composition. A series of articles on California roadsides begins on page 2.

Photo by Jack Meyerpeter

BACK COVER—Concrete piles for the first section of the Santa Monica Freeway march westward from the almost completed East Los Angeles interchange, the completed bridges of which span the Los Angeles River in upper center. Major street which crosses photo diagonally and over river and railroad tracks at upper right is Olympic Boulevard.

Photo by Robert Rose



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California Roadsides - I

State's Highway Planting Policy Has Grown Out of Special Problems of Terrain, Climate, Changing Pattern of Traffic

The roadside policy of any agency is bound to be strongly influenced by local conditions and attitudes. In the Middle Ages in England, there was a law requiring that all trees and shrubbery be removed for a distance of two hundred feet on either side of major travel routes, because they gave cover where highwaymen could lie in wait.

Conversely, many European countries have planted roadside trees for centuries, probably for delineation and dust control as much as shade. The frugal Europeans, mindful of their land shortage, often used fruit trees which were harvested by nearby inhabitants. Today, with the greatly increased motor traffic in Europe, this harvesting no doubt creates serious traffic hazards.

In parts of the United States where there is plentiful summer rainfall, highway landscaping is relatively simple. Shrubs and trees are usually already present. If not, they can be planted and grown with little maintenance except removal of weeds while the plants are small. Roadside grasses will stay green without watering, and can be kept mowed for a parklike appearance.

Editor's Nate: This, the first in a series of articles on landscaping and other roadside problems on the California State Highway System, covers the background of today's policy and practices. Future articles will cover implementation of the policy, maintenance problems, and the division's fund of knowledge of plants.

The series has been prepared by John Robinson of the Public Information Section with the assistance of various staff members concerned with planning, planting, and maintenance of roadsides.

California Climate Difficult

In California, and those other western states which have Winter-wet, Summer-dry climates, landscaping is much more complicated and expensive. In much of California there is no rainfall at all from about mid-May until mid-October—sometimes not until late November or even December. Few trees and shrubs can live through such a long drought, especially when that drought season is also the hot season. Yet California today has thousands of miles of clean, attractive roadsides with handsome planting and pleasant vistas.

It has not always been that way. In the 1880's and 1890's most roads in most states were morasses in wet weather, choking dust pits in dry.

The "good roads" movement began to gather momentum toward the turn of the century, but maintenance of such roads as existed all too often merely consisted of passing over the road with a grader once or twice yearly. Sometimes the sides were ditched. There was little road money and many taxpayers literally worked out their road tax.

With virtually no subgrade, vehicles would sink to their axles in mud in the rainy season, so it was desirable to dry the roads as quickly as possible in the spring. By mid-summer, of course, these same roads were impossibly dusty.





Photo at left, taken about 1905, shows "Winters-Dovisville Oiled Earth Road" (Yolo County). Roadside trees are black walnuts planted some time in the last century. This section is no longer state highway but trees are still there as shown by recently taken photograph at right.



Early vintage Cadillac (note right-hand drive) plows through mud of US 101, El Camino Real, about 1912, in Ventura County. In summer this same section would be impassibly dusty. It was paved in 1915.

Sprinkling became popular, and as more money was available, most counties bought one or more sprinkling wagons. When California's first Highway Commission inspected all the county roads of the state, the members commented time after time, in the 1895-96 report, on this problem of keeping roads from getting neither too wet nor too dry.

Tree Planting Recommended

Speaking of Los Angeles County, they said, "The planting of trees of a deciduous nature along the sides of the highways should be inaugurated. Trees of this character should be planted so that their foliage may shade the roadway during the heat of summer, while during the wet winter months their barren limbs offer no obstruction to the rays of the sun, which remove all excess moistures. The further development of sprinkling should be carried on as rapidly as available funds will permit." (At

Below: This type of road, actually a wagon track following contours, was landscaped by Mother Nature.





In early days of road expansion, cuts were made steep to save money, but savings were lost when slides became serious problem in wet season. Above is ridge route about 1915.

that time it cost about $75 per application to sprinkle a mile of road, the cost varying with the availability of water.)

The Commissioners recommended roadside trees for virtually all the counties, and the comment on San Joaquin County is typical: ". . . rainfall renders the roads impassable during the rainy season on account of mud, while the unrestricted action of the sun during the summer months makes the grinding of the roads into dust a certainty." San Joaquin County, of course, was not better nor any worse than the others.

This report bore fruit and many of our older roadside tree plantings date from about 1900. Some of the old curving rights-of-way may still be seen marked by double rows or trees in fields near present roads, a new alignment some time in the past having left them stranded like oxbow lakes of a river.

Road Oil and Trees

With the introduction of oil for road surfacing a few years later, roadside trees seemed less important. At that time, it appeared oil would control the dust problem. But this was a temporary attitude, for road oiling was expensive and there wasn't enough money to treat all the new roads being opened up after the invention of the automobile. Furthermore, many maintenance men insisted trees were helpful, oil or not. Actually, the Highway Commission continued an active roadside tree planting program for another thirty years—and might still be pursuing it had not traffic speeds made the roadside tree a hazard.

Even by the early 1900's the automobile, beginning to be seen occasionally on the highways, was creating new standards and needs. County road commissioners complained that their roads theretofore had been built to withstand the cutting action of iron tired wagons and animal hooves, but that the automobile tire sucked the surface off the roads, causing pockets and ridges rather than ruts. This sucking action, and the suction of the vacuum created in the wake of the faster

Below: With improved design and increased speed of the motor car, the old short radius curves and contour-following roads developed high accident records, and had to be realigned. This is a section of the Ridge Route on US 99 which was realigned in late 1920's. The old reversing-curve alignment shows clearly.



moving vehicles, made the dust problem worse.

After California's first Highway Bond election in 1910 provided funds for a network of state owned roads, the Commission began to think of planting from more than a maintenance point of view. Voices were beginning to be raised asking for road beautification and scenic highways. By this time, the automobile was the dominant factor in road planning although it was still essentially a novelty and luxury for most people rather than the everyday necessity it has since become.

The Sunday Driver

There were taxis and buses and trucks, of course, but most people used their cars for pleasure. The "Sunday Driver" was king. He liked to make pleasant drives at 20 or 25 miles per hour along shaded roads, preferably those roads which had places to turn out and look at a view, or to stop and picnic. On any "nice" Sunday in those days picnic parties could be seen scattered through the rural areas at likely spots near the highway, their cars pulled up beneath a roadside tree.

All this "pleasure driving", this "going for a drive", precipitated another Gold Rush. Myriads of roadside businesses catering to the motorist began to develop. With a few dollars to buy wieners and rolls, any sort of primitive stove, and a day's work with scrap lumber and canvas, a man could go into business. Almost every farmer had a vegetable "stand". The cities were encircled at easy driving distances by "roadhouses".

This fierce competition for the motorist's dollar developed a roadside nightmare. An enthusiastic entrepreneur might place crudely made signs every hundred yards for a mile in either direction from his place of business, only to have a newly arrived competitor intersperse between the first signs a new series of bigger, uglier and more blatant ones. Many of the structures were worse than the signs. Gasoline service stations of wire and burlap were not uncommon. As early as 1912 the California Federation of Women's Clubs was working for signboard control and roadside cleanup.



A resurfacing job going forword on another stretch of US 99, near Wheeler Ridge south of Bakersfield, about 1922. Note young roadside trees, planted about 1920. Due to lack of experience of planters, many trees planted in those days were not adopted to climate and soils.

Also in 1912, the Highway Commission adopted a resolution recommending the protection of timber growing near the roads in the forest districts "to enhance the scenic beauty and attractiveness through wooded portions of California". Landowners were urged to deed 100-foot wide strips of standing timber with right-of-way grants. (In the early 1920's, the Lagoon Lumber Company of Humboldt County actually gave the Highway Commission 25 miles of right-of-way 80 to 100 feet wide, with timber, for U. S. 101 between Trinidad and Orick.)

Roadside Problem Threefold

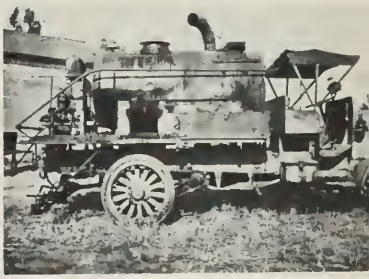
By the time of the U. S. entrance into World War I in 1917, it was apparent that there were three areas of action in dealing with the roadside problem.

The first and oldest part of the problem was the one of *roadside trees*. These were essentially part of the maintenance program.

The second part of the problem was *roadside clutter and signboards*.

The third part of the problem was *highway beautification*, a broad term which even today can mean either conservation, functional planting, or expensive landscaping.

For many years the only part of the three-sided roadside problem given





Two early types of road oilers. Horse drawn vehicle (below) used about 1913 was gravity flow, would only work in warm weather. Motorized model (above) had heater and pump. Both required a driver and an operator who rode seat in rear.



Early photograph (about 1930) of Mexican fan palm roadside tree planting in Riverside shows success of adapted variety.

much attention was the tree program. Drivers like shady avenues. Also, the dust problem was by no means conquered. A report from District IV as late as 1917, complains about the condition of the heavily traveled road through the Santa Cruz Mountains to the popular Santa Cruz beaches. "This route", the report says, "was constantly worked up into deep dust under the many wheels" so that a large portion of maintenance funds had to be spent on sprinkling.

In 1918, the Highway Commission accepted maintenance of all trees on the state highways, whether they had been planted by private individuals or not. Soon after this a working agreement was made between the Highway Commission, the State Board of Forestry, and the Department of Landscape Architecture at the University of California at Berkeley.

This group, known as the Tree Planting Committee, was to develop a plan for highway beautification over the entire state highway system, and advise the counties on their tree problems as well. One outgrowth of the plan was the establishment of a state nursery on a 30-acre tract near Davis, with the Division of Forestry administering it. At about this time, also, the Highway Commission hired arboriculturist W. E. Glendenning as its first full time employee in charge of roadside trees and road beautification.

Nursery Releases Trees

In 1921, the State Nursery released its first trees. A total of 7600 black walnut, European sycamore, Lombardy poplar, American elm, and black locust were turned over to civic groups for roadside planting.

Although civic groups were by then doing the major portion of the tree planting, it was no longer done in whatever fashion the owner of the abutting property wished. To plant roadside trees, a permit was required from the Tree Planting Committee. A planting plan was issued with the permit, and a highway survey party staked the area.

No trees were allowed within 100 feet of road intersections, within 200 feet of railroad crossings, or within 75 feet of inside curves. Trees were planted 100 feet apart on alternate sides of the roadway, which gave an apparent interval of 50 feet. Holes for planting had to be 3 feet deep and 3 feet in diameter, the tree supported by a stout stake and protected from animals by a wire guard.

Plantings cost about $1 per tree unless there was hardpan to be broken. Sometimes a contract was let for the plantings, sometimes they were done by public spirited individuals. In Orland 350 citizens once turned out and planted seven miles of trees in one day.

Part of the agreement was care of the trees for a year. Later this was changed to a cash deposit to cover one year's maintenance. After the first year the Highway Commission accepted responsibility for care and replacement. In general, about 80% to 90% of these plantings survived.

Trees Aid Maintenance

The tree program got further support in the early 1920's when the Highway Commission established a test road at Pittsburg, Contra Costa County. One part of the program showed the great deterioration hard surfaced roads suffered when exposed to the daily cycle of temperature extremes between noon and night. (The highway engineer's rule of thumb says that temperatures of 100° F. on a clear day mean as much as 140° F. at the pavement, depending on the type of surface, when the road surface is in the full sun.) Shade trees greatly reduce these surface temperatures.

Further evidence for the trees was developed through studies of a section of road in Imperial County which was planted to Long Beak Eucalyptus (*E. camaldulensis*). This section had required less maintenance and was in better condition than its adjacent treeless sections. The studies showed that not only had the trees shaded the surface and lessened the temperature extremes which often buckled the pavement in nearby unshaded areas, but also that the roots had sought the moisture beneath the roadbed and reduced sub-pavement water—the maintenance man's enemy.

In 1922, the State nursery released 60,000 young shade trees of various species, and the commission's planting plan proceeded on a systematic basis, adding about 100 miles of trees each year. In 1924, seven new water tank trucks were purchased for use in various districts, and the budget for maintenance of more than 100,000 trees was $41,000.

Nevertheless, constantly increasing traffic was already threatening the program. In February, 1924, the Commission said, "Until the requirements for widening state highways can be more definitely determined, tree planting is not being encouraged. It has been found almost impossible to protect young trees in many places where it has been necessary to lay new and wider pavements."

New Planting Policy

In 1927, a new tree planting policy was adopted, requiring that plantings allow for a much wider right-of-way. Great numbers of trees had already been and still were being planted, however, and the Division of Highways was now maintaining nearly 700 miles of them. New varieties were being tested, and there was consideration of the conflict between the trees and public utilities, such as telephone and power lines.

Despite this continued activity, the peak of roadside tree planting as a maintenance measure had passed.

Faster moving traffic and more of it required ever wider roads which either eliminated the trees or brought them dangerously close to the traffic. Wherever the trees were too close, motorists could not seem to avoid them, and "he hit a tree" became an all too common epitaph. Even today records of the Division of Highways traffic section show that such accidents include only about 1½% of the state total, but account for more than 4% of the fatalities!

Number two in the three parts of the early days roadside problem was dealing with signboards and roadside clutter.

Signboards Uncontrolled

As early as 1915 a signboard law was added to the statutes. It began "No sign, picture, transparency, advertisement or mechanical advertising device may be placed upon or over any state road or highway without a permit . . . and, if so erected shall be a public nuisance . . . " This law, however, only controlled signs on the right-of-way. There was no provision in the body of the law for control of a sign that was not on public property, such as a sign just inside a farmer's field, even though it was fully visible to the motorist and intended for his eyes.

Almost twenty years were to pass before an effective control could be established. Women's groups, conservationists, automobile clubs, newspapers, the Highway Commission, and many other groups called for action. The more farseeing of the signboard companies were also in the fight, for not only was the business getting a bad name, but an uncontrolled glut of signing would tend to defeat its own purpose.

In November 1928 the California Highway Commission adopted a resolution on the subject of signboards, in which civic organizations were encouraged to induce outdoor advertisers to discontinue certain objectionable practices. The resolution also pointed out that no law had yet been enacted in California which effectively controlled advertising signs on private property adjacent to public highways.

The first local zoning ordinance in California had been passed as far back as 1885 in Modesto, but it could not be enforced until it was fought through the State Supreme Court. The idea of any sort of control over private property was new and untried. Many other variations of the idea of zoning control were enacted in other communities throughout the country in the years ensuing, but it was not until 1926, in the case of the city of Euclid, Ohio, versus Ambler Realty Co. that a U.S. Supreme Court decision upheld the principle of comprehensive zoning.

Shortly after this the California Planning Act of 1929 stipulated "Any county, city, town, or township may make and enforce within its limits all such local, police, sanitary and other regulations as are not in conflict with general laws . . . to conserve and promote the public health, safety and general welfare." This act also said all counties must, and cities might, create a planning commission.

The judge in a Minnesota case said, "It is time the courts recognize the aesthetic as a factor in life. Beauty and fitness enhance values in public and private structures." A judge in a New York signboard control case said "Beauty may not be Queen, but she is not an outcast beyond the pale of protection or respect. She may at least shelter herself under the wing of safety, morality or decency."

Outdoor Advertising Act

In 1933, the Legislature passed the Outdoor Advertising Act which, with some changes and additions, is still in effect today. This law requires the licensing of all those engaged in the signboard business, and, exercising the state's police power, requires permits and conformance to certain standards, by all signboards visible from a public road outside city limits, whether located on private property or not. Minor exceptions are allowed, such as a sign located at a place of business, or a realtor's sign on a piece of property.

Signs cannot imitate official warning, stop, or danger signs, nor can they have red or blinking lights which might confuse drivers. No signs or structures may be placed within 300 feet of an intersection, within 500 feet of the inside of curves, nor in any position where they might divert or impede a drainage channel in time of flood. The law empowers the Director of Public Works, or his agent, to enter private property to remove or destroy illegal signboards if necessary.

Legal action prevented the Division of Highways from implementing the new law immediately. A company in Oakland obtained a restraining order pending court action and sued the Director of Public Works, attacking the

Below: Sylvan beauty marked this winding section of US 101 in Santa Barbara County, as seen in mid-1920's photo below, but it would be a nightmare to drive with today's cars and traffic.





Modern freeway section of State Sign Route 1 south of Santa Cruz. Simple roadside planting treatment here functions well for slope control, also blends roadside attractively into surrounding terrain.

act as unconstitutional on the ground it was double taxation and deprived persons of their property without due process of law.

On May 23, 1934, Superior Court Judge Fitzpatrick of San Francisco ruled for the Department on both counts, and there was no further contest of the act's legality. The decision had far-reaching effects, as a number of other states had such laws which had not been tested in court for constitutionality. Still other states were contemplating such laws.

Highway Beautificatian

The third part of the highway roadside problem—highway beautification—got little more than lip service for many years. When highway development in California began the roads were narrow, and built along the natural contours of the terrain. Such a road was a very minor, undisturbing element in the landscape.

Furthermore, although the need for roads was urgent, there was little money for construction, let alone beautification. In reading the 1896 report, it is obvious the commissioners were speaking of trees as maintenance tools, much as they might have discussed a road grader. (They did castigate the litter bugs of the 1890's who left dead horses and cows on or near the highways.)

It was not until 1912, two years after the State Highway System had come into being, that there was any discussion of road beautification. This was the year the Commission voted the resolution suggesting "landowners be encouraged to leave timber uncut for a considerable distance on both sides of the state highways. . . ."

Many landowners of the time did pledge that the timber on each side for a distance of 100 feet would not be cut. These agreements were voided later on, of course, when the state began buying right-of-way outright, rather than to continue to depend on the older easement sort of agreement in which the owner often made a number of stipulations.

When the route was selected for the Redwood Highway about 1915, the Commission wanted to buy 600 feet of right-of-way on each side of the route through the giant redwoods, but was unable to finance such a huge land purchase. When critics later complained because the huge trees were not protected, the Commission explained it had not been financially feasible and added, ". . . at that time the possibilities of the cutting off of the timber for many years, if ever, appeared very remote, but unexpectedly, with the opening of the state highway, a number of camps were installed for the cutting of the redwood trees into railroad ties and grapestakes. Some time intervened before friends of the redwoods awakened . . ." (and could take steps to save the remaining trees).

For the two decades after 1912, the attitude toward highway beautification was in this vein—primarily conservation of existing scenery through which the road traveled. Positive action was rarely advocated, except in the case of trees. Tree planting was constantly urged by garden and women's clubs, service groups, and other civic minded bodies. In many cases the groups actually did the work, and this program, with the roadside cleanup program, was their major roadside beautification effort for many years.

Trees and Traffic

About 1932, a number of things coincided to change this situation. As already stated, the tree program itself was faltering because of accidents involving trees, road widening, and realignment. In 1931, the State Assembly adopted a resolution requiring the Division of Highways and the Division of Beaches and Parks to report to the Assembly by January, 1933, progress being made on road beautification. The two divisions were to ". . . supply a definite leadership in the matter of roadside beautification . . ."

To a considerable extent, this resolution was a response to the new federal aid policy which was requiring that ½ of 1% of federal aid highway funds be spent on road beautification. This policy, (with the allowance later raised to 1%), remained in effect until approximately the beginning of World War II.

Another factor in the early 30's was the depression and the "make work" programs of those days. Drains, drinking fountains, guard walls and vista points were built of ornamental

. . . Continued on page 10



These two greatly contrasting roads are both California state highways. Above is a Sierra Nevada road photographed in 1941, now widened and resurfaced, but essentially the same today. Below is San Bernardino Freeway in the vicinity of Covina, with modern landscaping treatment.



CALIFORNIA ROADSIDES

Continued from page 8 . . .

rock. Ground covers, shrubs, and trees, were planted on slopes and at grade separation to prevent erosion and improve appearance.

In the 1930's also, the automobile had come a long way from the chugging, slow-moving vehicles of the 1900's. The new highways being built for faster moving traffic no longer meandered along the hillside contours. They traveled in wider, more sweeping curves for better sight distance, and with the straighter alignment, both vertically and horizontally, cuts and fills were much greater.

Slides Expensive

Not only were all these cut slopes unsightly, they were also difficult to maintain. Slides often dumped earth on the highways or undercut the fill sections, so that crews were kept busy clearing dirt away and restoring the roadway. Some districts found slope maintenance was getting the lion's share of their maintenance budgets.

Hence virtually all of the slope and cut plantings were for erosion control rather than job beautification, although the latter was usually a by-product. State Arboriculturist H. Dana Bowers (now Supervising Landscape Architect of the Division of Highways) wrote in 1932: "With few exceptions all roadside work done under the category of 'beautification' might well be called 'protection' or 'conservation', for aside from the fact that the roadsides are improved in appearance by such work, the important economic factor is not to be disregarded. Evergreen ground covers planted on slopes that tend to erode, and along roadsides to force out the natural weeds and grasses that constitute a fire hazard when dry, result in an enormous saving of labor and expense."

These words were written more than 30 years ago, but they remain the heart of State highway roadside planting policy today. Functional planting is still paramount, although even the simplest example of it contributes some beauty, and although reasonable expenditures for planting of the landscape-beautification type have been made for many years and are still being made.

How today's roadside planting policy is implemented, the initial and upkeep costs involved and the reasons for them will be discussed in forthcoming articles.

A joint meeting of the California Highway Commission and State Park Commission was held on January 25 in connection with highway and park planning at Emerald Bay, Lake Tahoe.

The San Francisco-Oakland Bay Bridge recently experienced frost on the upper deck during the early morning hours. It is the first time in its history that it has been necessary to spread sand in limited areas as a protection against skidding.

FOUR CONGRESSMEN INSPECT INTERSTATE PROGRESS



Members of the congressional delegation and the State Department of Public Works inspect the graving dock in Alameda for casting sections of the Webster Street Tube now under construction. Left to right are: Representatives John J. McFall of Manteca, Jeffery Cohelan of Berkeley, George P. Miller of Alameda, John F. Baldwin, Jr. of Martinez, and Frank Chambers, chief deputy director, and Robert B. Bradford, Director, both of the State Department of Public Works.

Four members of the California congressional delegation, including two members of the House Committee on Public Works, received a briefing on the state highway program and and a report on Interstate planning and construction progress on November 15, followed by an inspection tour of San Francisco Bay Area freeway projects.

The Congressional participants were Reps. John F. Baldwin, Jr., of Martinez, Jeffery Cohelan of Berkeley, George P. Miller of Alameda and John J. McFall of Manteca. Reps. Baldwin and McFall are members of the Committee on Public Works.

After being briefed by State highway officials in the San Francisco District office, the legislators boarded a bus for a guided tour ofthe MacArthur Freeway (US 50) construction in Oakland. At the resident engineer's headquarters on this Interstate project they were shown the various testing devices and procedures used to make certain that all aspects of the job conform to approved standards and specifications.

The Congressmen also visited the site of the Webster Street Tube project in Alameda and the graving yard where the tube sections are precast. This is a Federal-Aid Urban project.

The tour concluded with an inspection of recent and current work on the Nimitz and Bayshore Freeways.

Carson Spur

Public's Patience Eases Job Of Widening on Highway 88

By J. L. NICHOLAS, Resident Engineer



On August 10, 1960, without ceremony or fanfare, another project in the program of realigning and widening of Highway 88 was completed. The section involved in the project is 58 miles east of Jackson, and lies between 7,000 and 8,000 feet in elevation, and extends from the Carson spur in Amador County to a point 0.2 mile east of the Alpine County line with an overall length of 2.09 miles. At this easterly end of the project stands the old Kirkwood Inn which has been a landmark in this area since 1856.

The contract for the job was awarded on June 16, 1959 to Carey Bros. Construction Co. of San Anselmo, and work was started immediately.

Probably the biggest problem on the the project was the passage of traffic through the job while construction was going on. There were no parallel roads within many miles which could be used as a detour. The Contractor was allowed to close the road for periods of 2½ hours during the day beginning at 7 A.M. and ending at 6 P.M. The 6 P.M. limit was later extended to 9 P.M. to allow the Contractor a longer working day. The road was open for traffic all day on weekends and holidays, however.

Notices Printed

To keep the traveling public informed of the road conditions and the closing time, there were notices printed in various newspapers throughout the area; and, also, handbills with the closing schedules were distributed to various agencies, service stations, motels and hotels for distribution to tourists planning a trip over Highway 88. The Amador County Chamber of Commerce also printed handbills with closing schedules and items of interest regarding the road and distributed them as did the State.

Large signs were also placed at various locations within a radius of 50 miles of the project indicating the road being closed and also the closing schedule.

Even though it was sometimes necessary to delay some motorists for the full 2½ hours, there was hardly any complaint heard about this inconvenience. The State also provided sanitary rest facilities at each end of the project for the public's convenience.

The bulk of the roadway excavation on the job was within a few hundred feet of the Spur and the material was hauled for embankment throughout the whole job.

A view of Carson Spur, looking westward, following completion of the widening project.





A view of the highway around Carson Spur before construction was started.

Work Is Suspended

When the clearing, grading, drainage work and other minor items were completed, it was so late in the fall of the year that it was impractical to attempt placing the base rock and paving the project. The work was suspended until the spring.

Material for the base rock and the paving material was processed at a Forest Service materials pit in Hope Valley and hauled to the job, approximately 14 miles in distance.

There was no difficulty encountered in completing the project.

The route of which the Spur project is a part is of some historical interest in the State. The old emigrant trail established by Kit Carson over the Carson Pass approached the Spur but, because of the impassable terrain of that particular area, the trail turned to the south at the east end of Capels Lake (now known as Twin Lake) and extended to the higher ridges past Emigrant Lake and bypassed the Spur. The trail continued past the south side of Silver Lake and eventually came back to the now existing road near Tragedy Springs. This was a popular route for many settlers attracted to California during the Gold Rush of 1849.

Originally A Toll Road

In 1852, a group of business people from the Mother Lode area and the Stockton area obtained a toll road franchise and sponsored work to excavate a bench across the Spur and build a road from Capels Lake to Tragedy Springs. It is believed that the toll road was not a paying venture but, the franchise lasted for approximately 13 years.

Succeeding this franchise, several local groups operated and maintained the road until post offices were established at Kirkwood Inn and Silver Lake. When the post offices were opened, Alpine and Amador Counties assumed the maintenance and reconstruction work on the road.

In 1911, the State Legislature passed an act establishing the Alpine State Highway and, since that time, the State has assumed the maintenance and construction work.

It is said that the first toll road over this area was the route of the famous Pony Express Riders during the first six weeks of their history. It was the route of hundreds of settlers coming into the San Joaquin and Sacramento Valleys.



A section of the new reconstructed highway in the vicinity of Carson Spur. Mosquito Lake is on the far side of the road.

The most hazardous winter road surface condition is ice near or at the freezing temperature.

Loop Progress

L.A. Freeway Completions Will Bring Traffic Relief

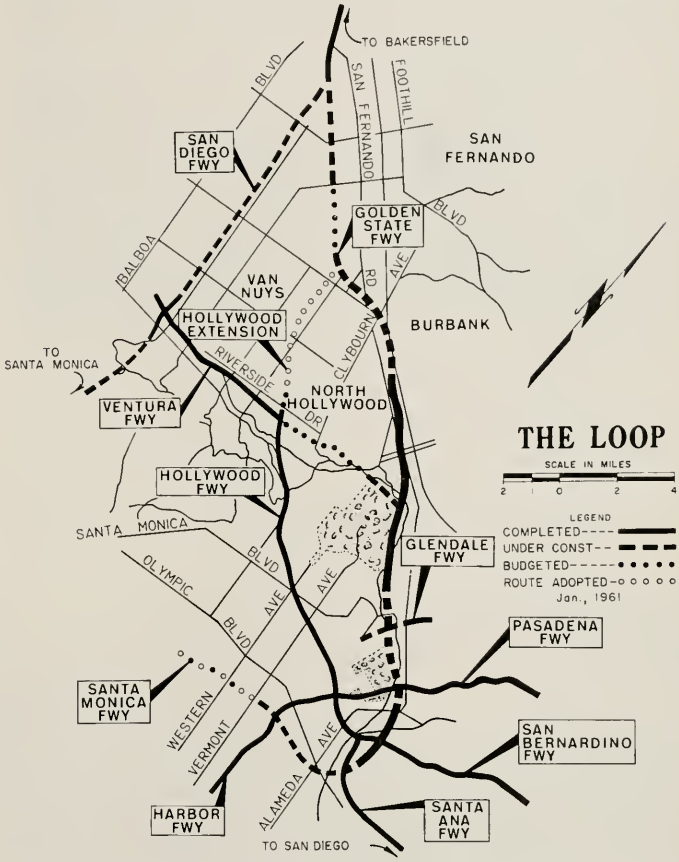
By A. L. HIMELHOCH, District Engineer—Operations



More than a year has elapsed since the appearance in *California Highways and Public Works* (September-October, 1959) of an article entitled "Freeway Loop" by Lyman R. Gillis, then District Engineer and present Assistant State Highway Engineer on Headquarters staff. In the intervening months great strides have been made in the development of the freeway loop, both as to projects completed and opened to traffic and projects awarded and budgeted for construction. It is the purpose of this sequel article to take up where the first left off, by relating the progress made so far in closing the loop.

The name "Freeway Loop" has been given to a combination route formed by portions of the Santa Monica and Golden State Freeways, circling downtown Los Angeles on the south from junction with the Harbor Freeway at Venice Boulevard east to the East Los Angeles Interchange at Seventh and Soto Streets; thence northwesterly across the San Bernardino, Pasadena and Glendale Freeways to Lankershim Boulevard in the San Fernando Valley (see sketch map). In this discussion the freeway loop will be said to extend beyond Lankershim Boulevard as far north as the San Diego Freeway junction near the San Fernando Reservoir. The total distance via the loop from the Santa Monica-Harbor Freeway interchange to the Golden State-San Diego Freeway junction is 28.69 miles.

As of January, 1961, there were 10 projects under way along the loop: four on the Santa Monica Freeway between Vermont Avenue and the East Los Angeles Interchange, totalling $31,179,717; one at the East Los Angeles Interchange, totalling $10,326,600; and five on the Golden State Freeway, totalling $47,988,900. The 1961-62 State Highway Budget contains an additional $6,200,000 for construction on a final Golden State Freeway project, bids for which will be opened this year. Previous budgets had financed such completed projects as bridge structures across the Harbor Freeway at Venice Boulevard and the Los Angeles River and adjacent railroad tracks near Olympic Boulevard on the Santa Monica Freeway ($5,510,000); and portions of freeway between 6th Street and Pasadena Avenue and between Glendale Boulevard and Burbank Boulevard on the Golden State Freeway ($22,189,000).



Santa Monica Freeway Viaduct

The east-west portion of the loop is formed by the Santa Monica Freeway connecting the Harbor Freeway and points as far westerly at Vermont Avenue with the Santa Ana Freeway. Eventually, of course, the Santa Mon-

ica Freeway will terminate at the Pacific Coast Highway in Santa Monica. The current contracts provide for continuous viaduct structure in a highly industrialized and densely traveled section of Los Angeles some 17 blocks south of the Los Angeles Civic Center. Taken individually from west to east, the contracts in progress break down as follows: Vermont Avenue to Oak Street, 1 mile, awarded to the Guy F. Atkinson Company on December 23, 1960, for $4,897,617; Oak Street to Main Street, 1 mile, awarded to the Griffith Company on July 11, 1960, for $9,682,000; Main Street to Hooper Avenue, 1.2 miles, awarded to the Griffith Company on May 17, 1960, for $7,295,300; Hooper Avenue to 8th Street, 1.1 miles, awarded to the Griffith Company on March 23, 1960, for $9,304,800. The total length of the viaduct section, which ends at Hoover Street, is 4 miles and is scheduled for completion in 1962.

Taken as a whole, the Santa Monica Freeway portion of the loop lists an impressive array of major construction quantities, among them 2,300 columns of varying dimension, 93 acres of bridge deck surface, 17 miles of concrete cast-in-drilled-holes piling, 270,000 cubic yards of structure concrete, 1,600 tons of structural steel, 43,000 tons of reinforcing steel, 620 tons of miscellaneous steel, 26½ miles of bridge railing, and 832 precast, prestressed concrete girders 50 to 95 feet in length.

Crosses 38 Streets

The 8-lane viaduct structure crosses 38 city streets at a height of 20 feet, with greater height clearances at railroad separations, the Harbor Freeway Interchange and the Los Angeles River Bridge. Ten streets will be deadended and 4 relocated, with all streets remaining open to traffic during construction. The east and west roadways will be separated by a 3-foot concrete barrier railing supporting a translucent light-diffusing fiberglas shield designed to reduce nighttime headlight glare. The over-all separation between roadways will measure 17 feet including median and shoulder area, with 8-foot outside shoulders. Mean width of the structure, taking into account the distribution roadways, will be 145 feet. Bridge decks will be poured to a standard 6½ inch thickness.

The stilt-like millipede structure has required an enormous quantity of tubular steel falsework for the pour work, amounting to 14,000 frames of from 4 to 6 feet in height, which if laid end to end would stretch 75,000 feet. The cost of these temporary supporting structures was $500,000. Equally impressive in the building of this massive bridge has been the labor force of approximately 1,000 contractor's and Division of Highways' personnel.

The contractor's resourcefulness in carrying out a multi-million dollar freeway project of this complexity was demonstrated in a mobile pouring unit of his own manufacture, which in effect was a travelling conveyor machine. By means of hopper and "elephant trunk," it was able to transfer ready concrete from stand-by transit trucks to the head of the column form for the pour. This method of direct delivery resulted in considerable time savings. Normally, it would require an hour's time to pour a single 20-foot column; however, in utilizing the so-called "travelling elephant" the contractor cut the entire operation to less than 15 minutes per column.

Problem Is Solved

An apparent problem, ingeniously solved by the contractor, was encountered in initial clearing operations with the presence of a large amount of concrete building slabs and foundations within the freeway right of way. This material, amounting to 80,000 tons, had to be removed before construction could start. What could have proved to be a troublesome disposal problem was solved in the following way: The contractor set up crushing plants at three sites, where the concrete rubble, after it was broken up by truck-mounted pavement breakers and ripper-equipped bulldozers, was hauled and reduced to aggregate size for base material and then incorporated into the ramp fills and frontage roads.

The Santa Monica Freeway viaduct structure will allow limited space for storage or parking within State right of way beneath the completed super-

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Cast-in-hole Piles Used on Loop Job

By CHARLES E. MAREK
Senior Engineering Geologist

About three years ago, the question was asked, "Why not use one 4′ diameter cast-in-drill-hole friction pile to carry the equivalent load of a number of smaller diameter piles?" This question was taken under consideration by the Bridge Department of the California Division of Highways for use at the proposed Santa Monica Freeway Viaduct in Los Angeles, linking the Santa Ana and Harbor Freeways.

The first problem was to determine whether the geologic conditions at the site were suitable for this use. Borings were made to a maximum depth of 85 feet. The material encountered was silty sand with some lenticular bodies of cobbles. The bearing values of the foundation material ranged between one ton per square foot near the surface to over five tons per square foot below a depth of forty feet. Borings were made twice the depth of the estimated pile lengths to assure that stable material existed below the pile tips. The absence of ground water led to the conclusion that cast-in-drill-hole piles could be used.

Pile Lengths Vary

Design loads averaged 450 tons per pile. Pile lengths averaged 40 feet and varied with the column load and the shear strength of the soil. Piles were designed with a safety factor of at least two against shear failure. Extensions of the piles above ground serve as columns of the same diameter.

Due to the unusual use of piles in this manner and size of loads, test loads of at least twice the design load were required to prove the adequacy for the location and depth.

A simple and fast method of pile loading was needed. It was decided to load the test pile using hydraulic jacks working against a reinforced concrete reaction beam. Two 48″ anchor piles were placed to a depth of 45 feet on either side of the test pile (20′ center to center). The reaction beam was cast between the anchor piles over the test pile. The beam was 9.5′ high, the

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LOOP PROGRESS

Continued from page 14 . . .

structure. Under the present contract the storage area is being graded and chain-link fenced with gate access from adjoining streets. With completion of construction, these areas will be available to lease for public parking and other approved uses, thus converting what would otherwise be lost area to a useful and revenue-producing facility.

The Santa Monica Freeway viaduct section leads directly into the 135-acre East Los Angeles Interchange, bounded by 6th and 8th Streets and Boyle Avenue and Lorena Street. This immense project has been under construction since May 1, 1959, by Peter Kiewit Sons' Company under $10,326,000 contract scheduled for completion in April or May, 1961. It is at this location that the Santa Monica, Santa Ana, Pomona and Golden State Freeways will converge in an interchange complex of 32 single and double bridges and 2 miles of 2- and 4-lane roadway with as many as 27 lanes in cross section.

Some of the major quantities utilized in the construction of this interchange were 13,500,000 lbs. of reinforcing steel, 4,235,000 lbs. of structural steel, 63,000 cubic yards of bridge concrete, 23,000 cubic yards of paving concrete, and 1,500,000 cubic yards of roadway excavation.



Contractor's personnel and state engineers study a model of the East Los Angeles interchange. The model is in a plexigloss case located at the job site. Left to right are: Dave Roper, Resident Engineer; Norman Barnes, Contractor's Project Superintendent; Louis Steele, Senior Resident Engineer; Tom Kelly, Heavy Equipment Superintendent, and Jim Crayne, Bridge Resident Engineer.

The first order of work called for the detour of such heavily traveled city streets as Boyle Avenue and Soto Street adjacent to the project. As a matter of fact, detouring and traffic rerouting was a constant difficulty faced by the engineers, going hand in hand with normal construction. The Santa Ana Freeway, carrying an average daily traffic of 118,974 motor vehicles at Indiana Street, was peri-



A section of the Golden State Freeway under construction at Roscoe Boulevard.



Looking east along the cleared route of the Santa Monica Freeway from Vermont Avenue. The bridge structure (top center) crosses the Harbor Freeway.



Looking east along the Santa Monica Freeway viaduct construction connecting the Harbor Freeway and the East Los Angeles interchange (upper left) at the Santa Ana Freeway. Structure (top left) is the bridge across the Los Angeles River.

odically closed to traffic during the off-peak morning hours to allow the erection of huge structural steel girders spanning it. The closures, sometimes affecting all 8 lanes of the freeway, necessitated detouring of traffic over city streets. With heavy traffic loads on both streets and freeway, the restricted construction area and the tight transitions in timing, scheduling of operations was an exacting task.

As the working area was prepared, such utilities as water, gas, telephone, telegraph and electrical lines were relocated and kept in service while the bridge structures were built, at which time they were either incorporated into or adapted to the new structures. Grading operations could then follow for ramps and structures, for the interchange and for the future Pomona Freeway. Footings for a Pomona Freeway bridge were also placed. Storm drain and sewer work followed as working space became available. A storm drain from Hollenbeck Park Lake to the Los Angeles River, a 69-inch reinforced concrete pipe, was built and jacked under the Santa Ana Freeway to handle storm overflow from the lake.

Construction plans called for the completion of the easterly portion of the interchange first, so that traffic has had the use of certain completed ramps to and from the Santa Ana Freeway for some time now. These are the 8th Street outbound on-ramp, the Euclid Street outbound off-ramp, the Euclid Street inbound on-ramp, and the Soto Street inbound off-ramp.

Model Constructed

It is rarely that an engineer can visualize the fruits of his labor before a project is built, but this is true, in a special sense, of the East Los Angeles Interchange. As an aid to designers and traffic engineers, an exact scale replica (1 inch equals 50 feet) of the future interchange was built by the Division of Highways Bridge Department in Sacramento and later put on public display in Los Angeles, after which it was moved to the job site and housed in a building at Boyle Avenue and Opal Streets. It was of material assistance to the contractor and engineers in affording an overall projection of the job and in studying

the relative elevation of roadways, traffic and scheduling problems. The model also proved interesting to visiting engineers and the general public.

Golden State Freeway

The north-south portion of the loop, and its longest leg, is formed by the Golden State Freeway. Until the East Los Angeles Interchange connection is built, the Golden State Freeway terminates presently at 6th Street and Boyle Avenue at Hollenbeck Park. From 6th Street to Pasadena Avenue the freeway is completed, including the interchange with and a realigned section of the San Bernardino Freeway. This 2.5-mile section built under two contracts amounting to $7,778,000 was opened to traffic on March 18, 1960.

Pasadena Avenue to Arnold Street

From Pasadena Avenue to Arnold Street, a distance of 1.7 miles, the Golden State Freeway is under $10,410,000 contract to Vinnell Corporation, Vinnell Constructors and A. S. Vinnell. Work started on May 11, 1960, and the estimated completion date is February, 1962. The project also provides for interchange with the Pasadena Freeway.

Part of this interchange is the Elysian Viaduct, a 2,480-foot bridge crossing the Los Angeles River, the Southern Pacific Railroad yard, the Arroyo Seco Channel and the Pasadena Freeway. This structure has 12 miles of supporting pile, 168 columns averaging 32½ tons of concrete each, 10 acres of bridge deck surface, 5,900 tons of structural steel, 2,675 tons of reinforcing steel, 22,900 tons of concrete and 2 miles of steel barrier rail. Columns are 4 feet in diameter and 16 to 18 feet in height. Longest of the steel girder spans, 175 feet, are over the railroad. The viaduct will pass over the Pasadena Freeway at a height of 21 feet and over the Los Angeles River bed at a height of 55 feet. South of the viaduct two bridges will carry the Atchison, Topeka and Santa Fe Railroad and the Union Pacific Railroad over the Golden State Freeway.

Construction began with relocation of utilities, sewers, and storm drains. It was also necessary to relocate a large facility of the Fuller Paint Com-



The East Los Angeles interchange, looking northeast. The dark raadway in the faregraund is the Santa Ana Freeway.



An aerial shawing fill stackpiles (whitish squares, center) placed prior to construction of the Golden State Freeway as an economical way of utilizing free surplus materials in advance of actual need.

pany. In an exchange of property, 7 of the company buildings were moved to a new, graded site. At Humboldt Avenue, on the southerly end of the job, a sewer syphon was constructed 40 feet below grade to connect with existing lines. A city dump, abandoned since 1931, was uncovered within the right of way and 375,000 cubic yards of unsuitable material removed from the job site. This task was complicated by ground water seepage and the necessity of installing pumping equipment over a 3-month period while 2 shovels scooped out the debris. There was sufficient suitable on-site material, 678,000 cubic yards, for fill replacement in the dump area as well as for the subbase, base, and structure backfill.

Some traffic detouring has been necessary on the Pasadena Freeway in connection with construction of the interchange facility and connecting roadways. Temporary ramp closures have been in effect on the outbound freeway at San Fernando Road in order to permit driving of piles, pouring of footings, columns and caps, and erecting of steel for the Elysian Viaduct. Some lane closures are anticipated for the inbound freeway at Cypress Avenue. At this latter location, old bridge abutments will be removed in shoulder and median areas, the Pasadena Freeway widened to accommodate inbound and outbound ramps from the Golden State Freeway, and the southbound off-ramp from the Pasadena Freeway extended to Avenue 26. Closures have been re-



A crane with a hopper and elephant's trunk pours columns far bridge structures on the Golden State Freeway-Glendale Freeway interchange.



Completed interchange roadways at the East Los Angeles interchange.

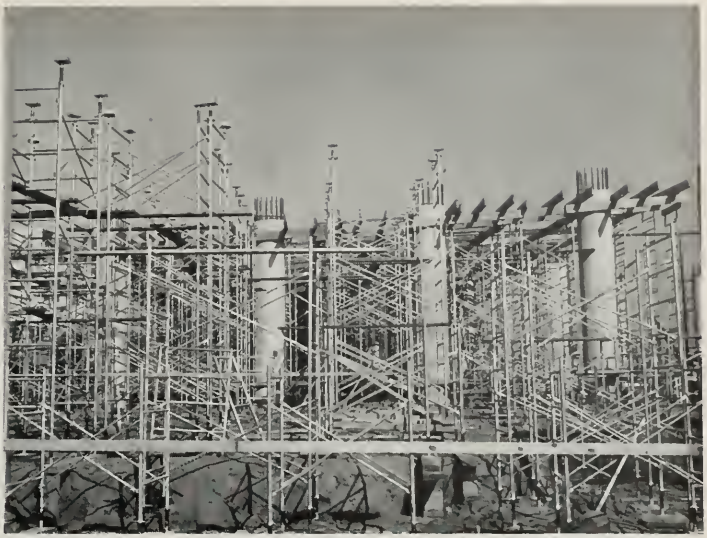


The Loop viaduct will connect to these bridge structures which were constructed over the Harbor Freeway under a previous contract.

stricted to off-peak hours in order to minimize interference with traffic.

Arnold Street to Glendale Boulevard

The Arnold Street to Glendale Boulevard section of the Golden State Freeway, which connects with the previously discussed job to the south, has been under $12,404,200 contract to the Guy F. Atkinson Company since April 20, 1960. The length of the job is almost three miles and the estimated completion date April 1962. A ¾-mile section of the Glendale Freeway and interchange facilities with the Golden State Freeway is part of this project and will complete the Glendale Freeway from just north of the Los Angeles River to Riverside Drive. (An adjoining $2,325,800 contract on the Glendale Freeway will extend it another .8 mile south from Riverside Drive to Glendale Boulevard. This project should also be completed in April 1962.) The major construction quantities are as follows: 2,700,000 tons of imported borrow (1,500,000 tons of which are being obtained locally, adjacent to the freeway at Riverside Drive and from Hollingsworth Pit, a haul of approximately five miles), 233,000 square yards of concrete pavement, 1,150 tons of structural steel, 8,000 tons of reinforcing steel for bridges, 567,000 cubic yards of roadway excavation, 18,000 lineal feet of chain-link cable-reinforced median barrier fence, 1,200 lineal feet of double blocked out metal beam barrier, 8,000 lineal feet of metal beam guard railing, 16,000 lineal feet of barrier railing for bridges, 35,000 lineal feet of chain link right of way fence and 68,000 cubic yards of concrete for bridges.



A side view of the complex of tubular steel falsework used on construction of the Santa Monica Freeway viaduct.

The entire project calls for 11 bridges plus the 8-bridge composite Glendale Freeway Interchange, which will have 12.7 miles of supporting pile, 69 columns ranging from 4 to 8 feet in diameter, 20 to 60 feet in height and averaging 58 tons of concrete each, 14 abutments and 6½ acres of deck surface. Bridges are of the reinforced concrete box girder, reinforced concrete slab and welded plate girder types. Roadway grades are such that a minimum 15-foot clearance is provided over Riverside Drive.

Fill Material Stockpiled

This Golden State Freeway section was used to stockpile embankment fill prior to letting of the actual construction contract. This economical practice is becoming more widespread throughout the District, wherever excess excavation may be had in advance of construction needs and where space is available to compact and store it according to State specifications and at



Earth moving and grading operations on the Golden State Freeway near Burbank Boulevard. Northbound freeway (center) is already in use.

no cost to the State. In this instance, fill in the amount of 600,000 cubic yards from other sources was stockpiled in the right of way, resulting in a savings to the public of an estimated $300,000.

The first order of work was the realignment of 1.5 miles of Riverside Drive between Arnold and Blimp Streets, with other frontage road construction, which is now completed. The bridge work is now 50% completed.

In conjunction with routine freeway construction, a 2,000-foot 72- and 84-inch reinforced concrete outfall pipe was built from the interchange along Allesandro Street to empty into the Los Angeles River, providing both freeway and local street drainage. Also, there was considerable revision of the existing sewer system and 6, 8 and 10 inch pipes were laid over a distance of 6,000 feet. Seven sewer pipes were located under the freeway and reinforced by concrete. One, a brick arch, was protected against the added weight of the roadway by a subterranean slab on piles.

In carrying out his schedules, the contractor has averaged more than $500,000 per month.

Glendale Boulevard to Burbank Boulevard

From Glendale Boulevard the Golden State Freeway is completed and open to traffic as far north as Burbank Boulevard. This 6-mile section was built previously under separate contracts: Ash Avenue to Los Angeles River, 2.2 miles, completed in September 1957, at a construction cost of $4,753,000; Los Angeles River to Glendale Boulevard, 2.5 miles, completed in January, 1958, at a construction cost of $5,418,000; and Alameda Avenue to Burbank Boulevard, 1.3 miles, completed in August 1959, at a construction cost of $4,240,000.

Burbank Boulevard to Roscoe Boulevard

Current contracts on the Golden State Freeway resume at Burbank Boulevard, with this section extending four miles north to Roscoe Boulevard. Work started under $8,830,400 contract to Ukropina, Polich and Kral on March 5, 1959 and completion is anticipated by June, 1961. Paving operations are currently under way.

The major construction quantities include the following: 1,000,000 cubic yards of roadway excavation, 380,000 tons of base materials, 56,000 tons of blacktop, 149,000 cubic yards of concrete, 15,000,000 lbs. of reinforcing steel, 18,000 lineal feet of storm drain pipe, and 21,000 lineal feet of sewer pipe.

A 3.7-mile storm drain channel has been an important feature of construction, since it more or less parallels the freeway alignment. Its point of origin is La Tuna Canyon south of Sunland and it empties into the Los Angeles River near Victory Boulevard. A $2,00,000 Los Angeles County Flood Control District and U. S. Army Corps of Engineers improvement, financed jointly by these two agencies but constructed as a part of the freeway contract, it courses in open and covered channel partly within the freeway right of way and passes under 5 channel bridges. These are located at Buena Vista Street, Cohasset Street, Hollywood Way, Lanark Street and Glenoaks Boulevard. The drainage facility is of the box type and its rectangular section measures approximately 30 feet wide by 14 feet deep. This combined use of space in a cooperative project is a fine example of cooperation between public agencies at State, County and Federal level, which results in great savings to the taxpayer.

Other work under this contract included relocation of Glenoaks Boulevard for a distance of 1¼ miles, and construction of the Burbank Boulevard Overhead, a concrete box girder bridge costing $800,000, spanning the Southern Pacific Railroad and Lake and Flower Streets, financed jointly by the City of Burbank, Southern Pacific Railroad and Los Angeles County.

Base materials and roadway excavation were obtained from the job, from a State-owned borrow site located on Glenoaks Boulevard. This source provided 750,000 cubic yards of roadway excavation and 250,000 cubic yards of subbase and base materials.

Stage Handling of Traffic

Because of the paralleling and overlapping of the new freeway alignment over the existing route for the first mile of the contract, it was necessary to construct the storm drain channel and freeway in stages while handling approximately 45,000 motor vehicles daily.

Prior to any freeway construction it was necessary to build three separate detours to handle traffic while portions of the Burbank Western Flood Control Channel were constructed. Two detours were required near Burbank Boulevard and one was constructed near the Front Street-San Fernando Boulevard junction.

About a half-mile of the northbound freeway from Burbank Boulevard to San Fernando Boulevard has been completed and is now carrying two-way traffic so that the southbound portion of the freeway can be completed.

A final staging of traffic will be necessary when the southbound freeway is opened to traffic, in that a four-lane two-way temporary ramp connecting the northbound freeway to surface streets at San Fernando Boulevard will he removed to permit completion of the northbound freeway in this area.

Roscoe Boulevard to Lonkershim Boulevard

The Roscoe Boulevard to Lankershim Boulevard section of the Golden State Freeway, covering a distance of 2 miles, has been under construction since December 1, 1959, by B. J. Ukropina, T. P. Polich, Steve Kral and John R. Ukropina, under $3,718,500 contract, tentatively scheduled for completion in June, 1961. Construction quantities include 50,000 cubic yards of concrete, 830,000 cubic yards of roadway excavation, 2,300,000 lbs. of structural steel, and 3,900,000 lbs. of reinforcing steel. This project will have 7 bridges, 1 pedestrian overcrossing and 1 pumping plant. Work began with routine clearing and grubbing, followed by utility relocation and frontage road construction. Bridges and frontage roads are now completed with paving operations scheduled to start in mid-February.

The single outstanding engineering feature of this project is the Sun Valley Overhead located between Penrose Street and Tuxford Avenue, which carries the freeway over San Fernando Road and the Southern Pacific Railroad, and measures 511 feet end to end. It has 5 spans of 20 steel girders



Looking northword aver the Golden State Freeway-San Bernardino Freeway interchonge. The Las Angeles County General Hospital is at right center.



Laaking north alang canstructian in progress on the Galden State Freeway from Hollywaad Way.



Golden Stote Freeway construction at Lankershim Boulevard (bridge in foreground).



Laaking north alang a completed sectian at the Golden Stote Freeway in the Burbank area from Western Avenue (bottom).



The Elysian Viaduct and Pasadena Freeway interchange on the Golden State Freeway. Note columns and steel already placed. Winding thraugh the phota at right is the Los Angeles River.



The Golden State Freeway-Glendale Freeway interchange. The Glendale Freeway will enter from the right acrass the Los Angeles River.

each and the longest span is 123 feet. Total weight of the girders is 1,375 tons.

When opened to traffic, this freeway section will have temporary connections to Lankershim Boulevard until the Golden State Freeway is extended north to Osborne Street.

Lankershim Boulevard to Osborne Street

On October 25, 1960, the California Highway Commission voted $6,200,000 for construction on the Golden State Freeway between Lankershim Boulevard and Osborne Street, a distance of 2.4 miles. This project, the last to be financed on the loop portion of the Golden State Freeway, will be advertised for construction sometime during 1961. Four hundred working days have been assigned to the completion of this freeway section, which will have 3 pedestrian crossings, bridges at 6 locations and 1 pumping plant.

Osborne Street to San Fernando Road

Bids were opened on January 5, 1961 for the most northerly end of the loop on the Golden State Freeway, between Osborne Street and San Fernando Road (junction with the San Diego Freeway near the San Fernando Reservoir).

Construction is now in progress under $12,625,800 contract to S. A. Healy Company and C.K.F.M. from funds made available in the 1960-61 State Highway Budget. The Golden State Freeway portion of this contract measures almost 6 miles of pavement, with the remaining mileage being on a 4-mile link of the San Diego Freeway south to Nordhoff Street, where retaining walls and pedestrian crossings will be built in conjunction with placement of excess fill for future freeway construction under separate contract. This double project will be completed in 600 working days from date of contract approval.

Within the aforementioned limits, the following structures will be built on the Golden State Freeway: pedestrian undercrossings at Kagel Canyon Street, Pierce Street, Filmore Street, and Chamberlain Street; undercrossings at Terra Bella Street, Van Nuys Boulevard, Paxton Street, Fox Street, Chatsworth Drive, San Fernando Mission Boulevard, Rinaldi Street and

Roxford Street; bridges at Pacoima Wash and East Canyon Channel; Mission Separation and Overhead; and the San Diego Freeway Separation. In addition, 8 retaining walls will be constructed.

The job calls for the following representative major quantities: 6,125,000 cubic yards of roadway excavation, 315,000 square yards of concrete pavement, and 8,516,000 lbs. of bar reinforcing steel.

Completion of the Golden State Freeway at this location will terminate the loop at San Fernando Road. Of course, the Golden State Freeway has been completed to largely expressway standards north of this point via the Ridge Route to the Kern County line and has been in use for a number of years. In terms of the loop, public traffic will have the use of a major 8-lane north-south facility from the north San Fernando Valley to the Harbor Freeway south of the Los Angeles Civic Center. In the next few years as more gaps are filled in the District's freeway system, an increasing number of new loops and alternate routes will circumscribe and cross the megalopolis of Los Angeles and vicinity and will more efficiently serve the present 6,900,000 residents and 3,650,000 motor vehicles in Los Angeles, Ventura and Orange Counties. The freeway development program, particularly on the Santa Monica and Golden State Freeways and on other Interstate routes, is accelerated by the Federal Interstate program, which finances 92% of the cost of these freeways.

Traffic Benefits

To provide adequately for the mounting volume of vehicular traffic, any large urban area, such as Los Angeles, requires some form of a freeway system, be it rectangular, radiating, circumferential, or a combination. Furthermore, this system should be well integrated with the local street system in order to provide optimum traffic service. It is not uncommon to find city streets almost devoid of traffic in the vicinity of a newly opened freeway. Until recently, estimates of future traffic on proposed freeways were in part predicated on traffic diverted from city streets.



Columns across the Los Angeles River and adjoining railroad tracks prior to erection of steel girders. This is the Elysian Viaduct section of the Golden State Freeway.

With more freeways being opened to traffic, diversion from the existing freeways will take place. This diversion will affect the commercial vehicles in perhaps a different amount than the passenger vehicles. On the other hand, construction of additional freeway facilities and the improvement of existing ones generates new traffic. Freeways are popular and as such will always attract an appreciable number of users; so that while new alternate routes will provide relief to congested areas, such as the "slot" in the Los Angeles Civic Center, no freeway will ever be without traffic.

To date, the Santa Ana and Hollywood Freeways have provided one of the best routes for commercial vehicles entering the Los Angeles Metropolitan area by way of the Ridge Route (U.S. 99) and Sepulveda Boulevard. With the completion of the Golden State Freeway through the San Fernando Valley and into the East Los Angeles interchange area, an even more direct route will be created.

The Golden State Freeway, although not intended strictly as a commercial truck route, will carry a higher than average percentage of commercial vehicles, many of which now use the Hollywood Freeway. The Santa Monica Freeway will provide the much needed route to points west.

Although commercial traffic will not disappear entirely from the Hollywood Freeway, it is anticipated that enough will be diverted to provide noticeable relief and increased capacity for passenger vehicles.

With the completion of the loop, it is reasonable to expect that about 15 percent of the existing traffic on the Hollywood Freeway will be diverted. The loop will also benefit the existing city streets because of the improved conditions on the freeways which will attract traffic from the crowded paralleling city streets. As the freeway network is expanded, alternate routes will allow for traffic adjustments which will further reduce congestion and delay.

SQUEEZE AND S-T-R-E-T-C-H

Expansion and contraction of the San Francisco-Oakland Bay Bridge is a continuous process which could amount to a variation as great as 10 feet from the hot summer to a cold winter. It is amply protected from such stresses, however, because its expansion joints can accommodate a change of more than twice the normal amount.

CAST-IN-HOLE PILES

Continued from page 14 . . .

width of piles, and contained about 40 yards of reinforced concrete (see *Figure 1*). The test beam was designed for 1,200 tons to be applied at the center of the beam.

The test pile was loaded in 50-ton increments in order to plot the normal expected settlement.

Settlement Is Checked

At 500, 900 and 1,150 tons the loads were removed to check the estimated permanent settlement (see *Figure 2*). Rebound readings were taken to determine permanent settlement under these loads. At 500 tons the pile rebounded to 0.105″ with a total settlement under load of 0.195″. At 900 tons (double design load held for 60 hours) the pile rebounded to 0.45″ with a total settlement of under load of 0.55″. Since the pile was designed to have a settlement of ½″, under double design load, the test proved the pile to be of satisfactory design.

Pile Is Tested

In order to determine the ultimate bearing capacity of the pile, an attempt was made to fail the pile. At a load of 1150 tons there was slow continuous movement, indicating the applied load exceeded the shear strength of the soil. A safety factor of 2½ was indicated.

Where the geologic conditions are such that this pile can be used (no ground water, and material that does not cave when drilled, see *Figure 3*) large diameter cast-in-drill hole piles may find many uses in future construction.

On this project, a savings of nearly 50 per cent was made over conventional multiple pile footing type foundations.

HRB HOLDS MEET

Nearly 3000 engineers, economists, planners and highway officials attended the 40th Anniversary Meeting of the Highway Research Board held in Washington, D.C., during January. The Board is a unit of the National Academy of Sciences–National Research Council.

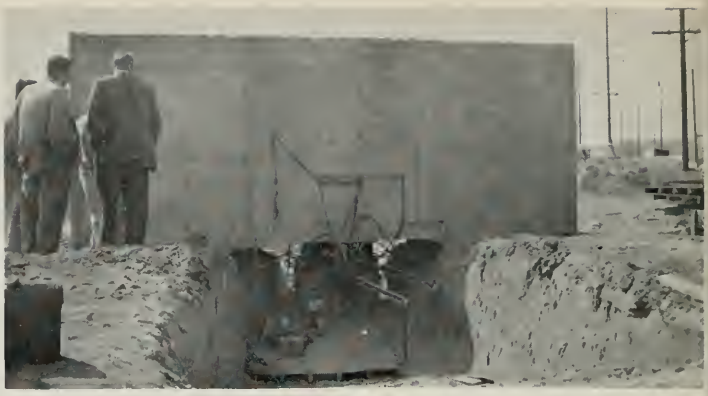


FIGURE 1. A test pile was loaded using hydraulic jacks working against a reinforced concrete reaction beam.



FIGURE 2. The test pile was loaded in 50-ton increments and the settlement checked at 500, 900 and 1,150 tons.



FIGURE 3. Geologic conditions must be right for the pile to be used; namely no ground water, and material that does not cave in.

Tube Report

Webster Street Underwater Tunnel Will Be Completed by Fall, 1962

By GEORGE A. GREENE, Resident Engineer
and E. G. POMEROY, Assistant Resident Engineer



THE NEW underwater Webster Street Tube providing two additional lanes of traffic under the Oakland Inner Harbor, between Oakland and Alameda, will be opened in the fall of 1962. The graving dock and construction yard are shown in the accompanying plate, "Plan—Graving Dock" have been provided for exclusive use on this contract.

The underwater portion of the tube will be 2400 feet long and will consist of 12 separate reinforced concrete segments each 200 feet long with an outside diameter of 37 feet, 30-inch shell thickness, rectangular collars 45 feet wide by 43 feet high at each end, and each weighing about 5700 tons with a submerged displacement of 7200 tons.

The casting of tube segments began in July, 1960, ten months after bids were opened in September, 1959, and four segments were completed by January, 1961. The casting of the remaining eight tube segments will be completed by October, 1961. The operation of sinking the segments to position and hooking them together is expected to begin during April, 1961, and be completed by January, 1962.

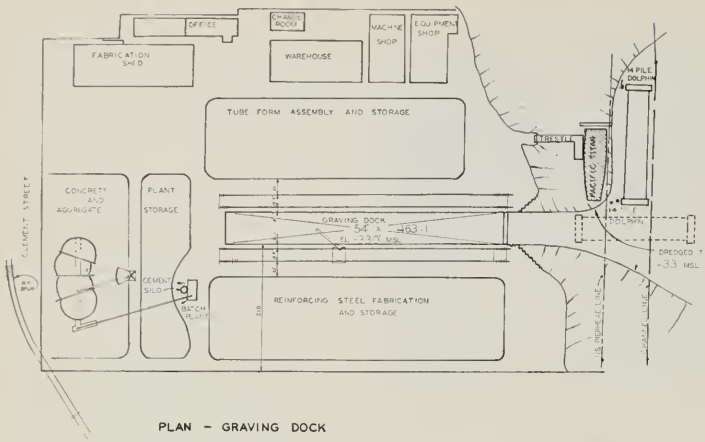
First Used in 1928

Since the completion of the Posey Tube only ten other underwater tubes have been completed using the method of sinking surface prefabricated sections in an underwater dredged trench; first used for a highway tube under the Oakland Inner Harbor in 1928.

Because of the comparative rarity of the "surface prefabricated section—



This picture shows the casting yard and the equipment used in constructing 12 precast tube segments, which cost o total of $4,440,000 when delivered to the right-af-way and ready for sinking inta position. The omount of the Division of Highways construction contract is $16,641,000, ond the contractor has invested about $800,000 in constructing the graving dock ond about $300,000 in tube farms. Two segments are constructed at the same time in tondem ond launched by flooding the dock ond removing the gate. A construction cycle requires about 10 weeks, and a high tide of more than five feet is required far launching. The segment nearest the water is cavered with timber lagging installed to pratect the waterproafing, while the ather segment shows the black waterproofing. (Phata by Aero Photographers)



PLAN – GRAVING DOCK

The eleven-acre construction yard is located in Alameda at Stanford and Clement Streets, and on the Oakland Inner Harbor opposite the eastern end of Government Island.

dredged trench" type of tube construction, the contractor has been required to conduct his own investigations and to submit his proposed construction methods and engineering calculations to the Bridge Department for review. The contractor's development and planning period required about one year and over 300 pages of working drawings and 400 pages of engineering calculations have been submitted for information and review.

Contract work began October 12, 1960 at the Alameda portal building. The unstable, constantly moving, soft bay mud south of the estuary has required careful planning and complicated construction procedures. The cofferdam and building sections are shown on plates "Floating Tube in Drydock," "Alameda Portal Building Section," and "Pump Sump and Weephole Detail."

The cofferdam construction, pile driving, and concrete subbase seal required six months construction time. The building construction below the ground line and cofferdam removal required another six months construction period. Total working time of 15 months was necessary to complete building concrete. The water level inside the cofferdam was lowered as the excavation proceeded.

Mud Is Removed

Ten feet of interior fill and mud were removed before excessive sheet piling wall deflections and local ground settlement outside the cofferdam indicated the necessity of interior cofferdam bracing. The first and second levels of the interior bracing grid were installed before excavating to third level of bracing. Excavating was interrupted at lower levels for the installation of cofferdam bracing. After the interior bracing at minus 29.5 feet was installed, the contractor filled the cofferdam with water before continuing to excavate. When the cofferdam was flooded the mud was rising in the bottom at an estimated rate of one inch per day, and the ground surface outside the cofferdam had settled about three feet.

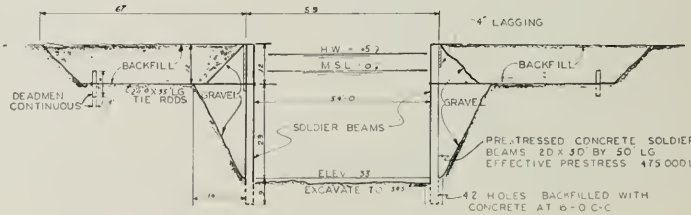
Additional ground settlement outside the cofferdam during the 6-month building construction period below the ground level increased the total ground settlement to about five feet. The additional settlement is attributed to the increased weight of the ground resulting from loss of bouyancy when the ground water table was lowered by draining into the cofferdam.

The Alameda portal building is supported by 124, 12-inch diameter, seven gauge steel pipe piles filled with concrete which extend 78 feet into the mud below the foundation concrete. The piles were 130 feet long when driven by a 6,500-pound, double-acting, steam hammer with 52 feet of pipe extending above cut-off elevation, to the water surface. A pile load test of 90 tons for 60 hours produced an acceptable permanent settlement of .065 inches in the bearing load test pile, and less than .001 inch of pull out on each of the anchor piles under 45 tons uplift.

Bottom Is Stabilized

After pile driving was completed the cofferdam mud bottom was stabilized and sealed with a pressure relieved type Class "A" concrete subbase seal. The subbase concrete was placed under water by tremie tubes over 1½ feet of rock filter blanket. The average thickness of the subbase concrete was 3.7 feet with a minimum of 1½ feet and a maximum of 4.5 feet. The hydrostatic uplift pressure under the subbase was relieved by pumping wells and weep holes cast in the tremie concrete and extending through the filter blanket.

After the cofferdam was dewatered, one 4-inch pump was adequate to remove leakage water and prevent uplift on the concrete subbase. The weep holes were capped and covered with the leveling course concrete and waterproofing. The basement slab of the building was 4'–6" thick reinforced



EXCAVATED SECTION OF DRYDOCK

The contractor had a choice of facilities in the construction of the 12 precast tube segments. They could be built in the dry in a dry dock or dredged basin or on skidways. He elected a graving dock, a section of which is here shown.

concrete, making a nine-foot total thickness of concrete below the basement floor level. The thick concrete building walls and floors are necessary to provide weight, in order to resist buoyancy forces and prevent the building from floating.

Bracing Removal Difficult

The removal of the cofferdam grid bracing was complicated by the high earth pressure on the sheet piling. The grid bracing at Elevation −29.5 feet was removed after filling the space between the building basement slab and the cofferdam with gravel topped with one foot of concrete. When the interior bracing was removed, the gravel and concrete backfill resisted movement of the sheet piling and transmitted the pressure loads to the building foundation.

The remaining four layers of grid bracing remained in place, and the contractor constructed the reinforced concrete structure around the braces.

Upon completion of the building exterior walls and interior concrete bracing members, the four layers of steel bracing grid were removed as the waterproofing and backfilling proceeded. The roadway opening in the building wall adjacent to the first precast segment is closed with a watertight bulkhead to prevent flooding the building when the first segment is floated into position.

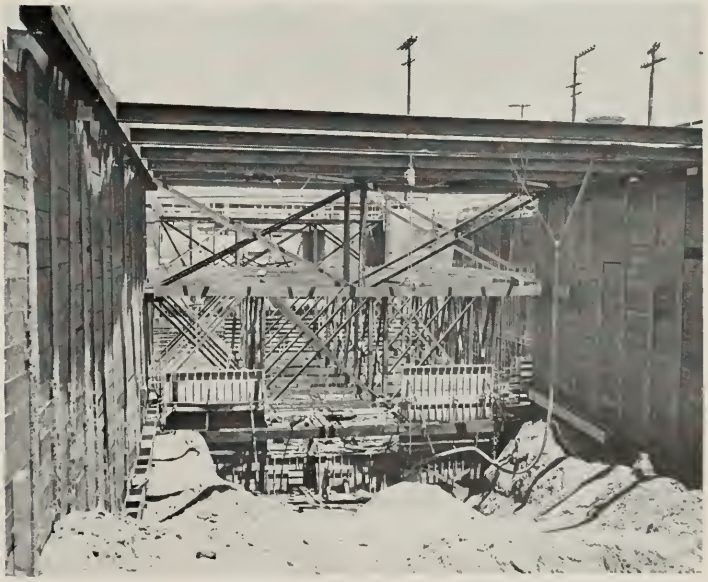
Installation of the building bulkhead was also complicated by the necessity for balancing the cofferdam earth pressures and transferring the cofferdam bracing forces to the building walls. The plan used was worked out by the contractor's engineers, and involved a sequence of eleven separate steps.

Oakland Foundations Favorable

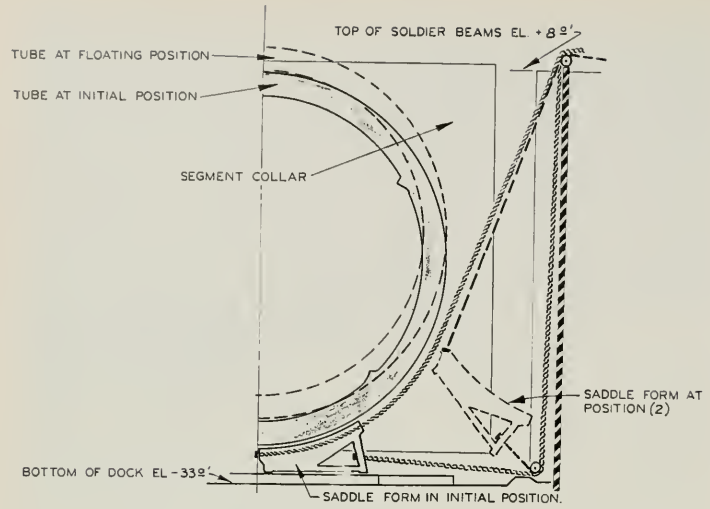
In contrast to the difficult soft mud conditions in Alameda, the foundations in Oakland are very favorable, consisting of dense sand with binder but still permeable enough to permit passage of water. The excavation for the Oakland portal building was shored with 18WF105# steel soldier beams placed vertically extending 11 feet below grade in predrilled holes at 5'-6" centers along the excavation line and driven to grade by a pile hammer. Timber lagging consisting of 4"x12" were placed horizontally between the



General location of the tube and the project. Note temporary lift bridge on the railroad shoofly. The soft mud is quite unstable and an excavation 450 feet wide is required to provide a stable underwater trench 60 feet deep and 40 feet wide at the bottom.

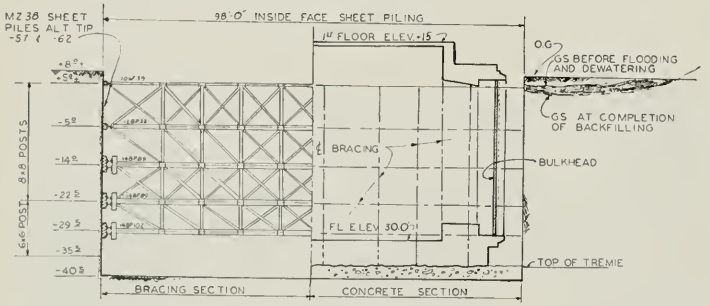


This picture of the Oakland Portal Building excavation shows the vertical steel beams and timber lagging used to prevent ground movement outside the hole. Ground water drains through the lagging and the wall pressure is greatly reduced. A pumping well in the foreground is used to lower the ground water.



FLOATING TUBE IN DRY DOCK

The graving dock is filled with water and the segments begin floating when water level reaches mean sea level. The 76 saddles are pulled out during the periods when the tide is one foot above mean sea level. The segments are towed out of the graving dock on the next high tide 24 hours later.



ALAMEDA PORTAL BUILDING SECTION

The cofferdam bracing system was installed while excavating was stopped at the brace level. The soft mud was impermeable and ground water entering the excavation was removed by a four-inch pump operating about three hours per day. The cofferdam was filled with water after the lowest brace was installed to balance the high soil pressures.

soldier beams to retain the earth. The soldier beams were braced by walers placed 10 feet and 28 feet below the ground surface and strutted by transverse bracing trusses at eleven-foot centers. The ground water surface was lowered in stages to a maximum of 40 feet in Oakland by pumping from a sump excavated in the bottom of the cut. The openings between the 4"x12" lagging provide drainage and prevent the build-up of hydrostatic pressure behind the shoring.

The precast tube segments are being cast in a specially constructed graving dock located in Alameda, two miles upstream from the tube right of way. The graving dock was constructed in a stiff clay foundation with very little inflow of ground water. An underdrainage system and weep holes through the dock floor slab relieve hydrostatic uplift forces. One hundred and forty seven prestressed concrete soldier beams were used to construct the drydock as shown in the accompanying plates, "Plan-Graving Dock" and "Excavated Section of Drydock."

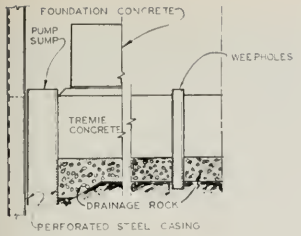
Plant Output Described

The concrete batch plant has a maximum output of about 100 cubic yards per hour and is located at the Casting Yard. All coarse aggregates pass through vibrating finish screens installed directly over the batch bunkers. Aggregates, cement, and admixtures for the precast tube segments are batched directly into 7-cubic-yard transit mixers for mixing and transporting to the forms, with a maximum haul of 800 feet.

Concrete used in the exterior walls of the portal buildings and cast-in-place tube is hauled by dump trucks in 3½-cubic yard batches to one of two transfer plants located on each side of the Estuary and then delivered to the forms by 7-cubic-yard transit mixers. A water-reducing retarder admixture of the hydroxylated carboxylic acid type and an air-entraining agent are being used. The retarding admixture is being used to extend the plastic period of the freshly mixed concrete until succeeding layers can be placed, permitting the additional layers to be internally vibrated together. The tube segment concrete is revibrated by external form vibrators. The retarder also densifies the concrete, provides additional workability, and increases the strength by 600 pounds per square inch after 72 hours. The air entraining agent is used to offset the densifying properties of the retarder, and is permitted because it also increases impermeability and workability.

Weight Reduced

The use of 4% entrained air reduces the weight of the precast segment about 220 tons, permitting the segment to float one foot higher when launched, thus extending the available working time for launching during high tide. The contractor is required to furnish freshly mixed concrete with a minimum unit weight of 147 pounds per cubic foot, and in addition four



PUMP SUMP & WEEPHOLE DETAIL

The use of a pressure relieved seal permitted a seal of average thickness of about four feet, whereas 25 feet of tremie concrete would be required without the pumping system. The drainage rock permits the underwater seepage to flow to the pump sump and weepholes and also supports the tremie concrete on the soft mud bottom.

precast segments are specified to have concrete with a 152 pounds-per-cubic-foot unit weight. The 147 pound weight can be supplied using 4% air; however, less than 4% entrained air is used in the 152 pound weight concrete.

The maximum size of coarse aggregate being used on the precast tube segments is 1½" because of the difficult placing and reinforcing bar congestion at some locations. The 2½" size aggregate is also being used in foundations and heavy sections.

The concrete for the precast segments is placed in three separate operations. The invert, or portion of the shell below the roadway slab, consisting of about 830 cubic yards, is placed first. The roadway deck slab consisting of 230 cubic yards is placed next, and the permanent tube shell is completed with the placing of 1,600 cubic yards in the overhead section of the arch, making a total of about 2,750 cubic yards per segment.

Measurements Made

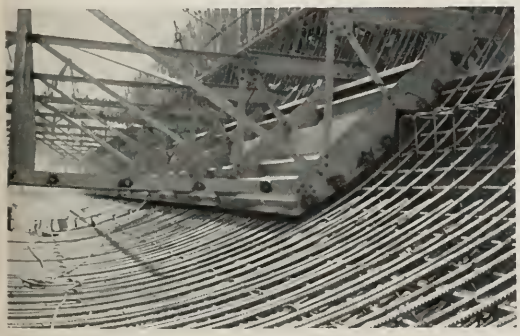
Concrete temperature measurements were made by thermacouples placed at the center of the 30-inch tube concrete arch shell. The outside of the tube barrel was exposed, but below the ground level in the graving dock, and the ends of the segment remained open during the water curing period. Air temperatures varied from 55° to 75°F and the water in the estuary was 62°F. The mixed concrete was placed at a temperature of 74°F, one day later the concrete temperature was 105°F, second day 91°F, third day 80°F, fourth day 73°F, seventh day 66°F and was 62°F twenty days later when measurements were stopped.

After the tube concrete placement is completed, the segments are waterproofed. The waterproofing consists of four moppings of type B waterproofing asphalt and three layers of glass fabric applied after the concrete is primed with an asphaltic cut-back primer. The exterior waterproofing on the segment is protected from possible damage by 2"x12" timber lagging.

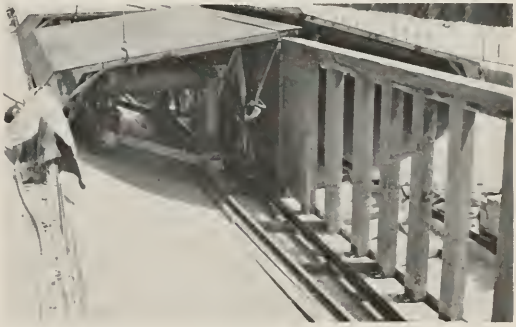
The segments are prepared for floating by plugging the ends with temporary bulkheads. A temporary reinforced concrete Tee-beam bulkhead closed the ends of the duct space under the roadway slab. The planking is caulked and covered with asphalt and glass fabric membrane water-



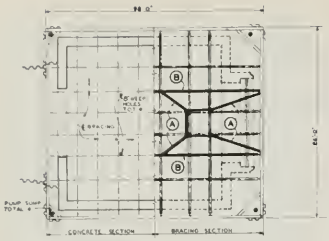
Tube segment being towed. The floating segment has about 8 feet of the 37-foot outside diameter exposed. The 5,700-ton segment requires 34 feet of water for towing and can only be moved during the high tide period. Eighty tons of water ballast is required in the stern in order to float the segment level. Note towers for locating the submerged segment and access hole near the front, which will be 50 feet to extend above the water surface on some segments. The generator on the front provides electricity for the interior lights and pumps. (Photo by Russ Reed)



A view of the tube reinforcement and the interior invert form.



The roadway deck form is being lowered into place and a portion of the longitudinal left open for the construction of a steel transverse bulkhead after completion of the deck concrete.



ALAMEDA PORTAL BUILDING PLAN SECTION

The battered struts A were installed to permit the removal of struts B which obstructed the circular correction concrete forms at the joint with precast segment No. 1. The pump sump was extended above the backfill and the cofferdam water level maintained below the floor slab until sufficient concrete was in place to overcome buoyancy forces. The installation of the watertight bulkhead in the building at joint was quite complicated, requiring a sequence of strut removal, partial bulkhead construction, and backfilling in four cycles.

proofing covered with 1" of gunite. The open ends above the roadway are closed by 6"x12" timber horizontal planking supported by 36 WF steel beams placed vertically.

Segments Are Ballasted

Ballasting of the segments is required to provide proper flotation characteristics, to permit lowering into place, to help hold the segment in position on the temporary supports, and to bed the segment into a permanent sand foundation bed.

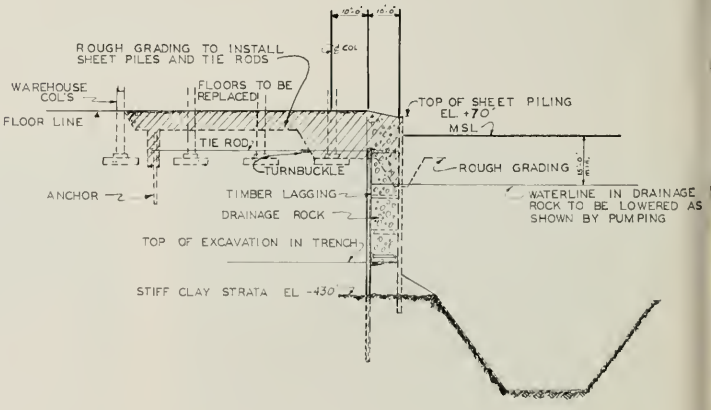
More than 2,400 tons of ballast will be added to the interior of the segments in order to complete the placing operation. It is estimated that about 800 tons of ballast will be obtained by filling the space under the roadway slab with water; another 1,000 tons of ballast will be added by placing about four feet of sand on the roadway deck; and the final 600 tons weight will be added by wetting the sand on the roadway.

The space under the roadway is divided into three watertight tanks by transverse bulkheads placed about 45 feet from the ends of the segment.

The segment can be balanced and the flotation angle controlled by changing the amount of water in the end ballast tanks. A perforated transverse bulkhead on the centerline will lessen the possibility of sudden surging of the water during the filling of the center tank.



The interior tube forms are being fabricated in panels five feet long and handled in sections 20 feet long consisting of four panels bolted together. Screw jacks on the jumbo adjusts the forms to accurate elevations and pull them loose for stripping. It requires about two days to move the forms to the rear segment after curing is completed.



BULKHEADS AT HAZLETT WAREHOUSE

The bulkhead is about 180 feet long with a 25-foot extension around the corner of the building along Water Street on the Oakland Waterfront. The last segment of the precast construction will be placed in the underwater trench about 80 feet deep.



The 45-ton graving dock gate is lifted about 20 feet by a 75-ton floating derrick. Note the horizontal bracing girders which transmit the water pressure to the reinforced concrete entrance section which provides a door opening 50 feet wide. The access manhole may be seen in the center of the picture together with the pipes which will supply air, and discharge water from interior pumps. About 1,000 tons of sand will be lowered through the 20-inch "conning tower" to provide four feet of ballast on the roadway slab in order to sink the segment. The "conning tower" will be extended as required to about 10 feet above mean sea level. One of the pipes carries fresh air and electric wires, while the other is a discharge line for interior drainage pumps. Also note the sighting masts which will determine the position of the tube segment when submerged.

Bulkhead Designed

A bulkhead for protecting the Tidewater Oil Company facilities was designed, approved, and constructed before the dredging could begin. The floating dredger Holland began work in January, 1960. A shoofly lift bridge on a Southern Pacific Railroad track was also designed and constructed and opened to railroad traffic in April, 1960, after the railroad had completed installing derails and signals.

The longitudinal top bracing and the lift span of the bridge were removed by a 75-ton derrick to permit the dredger Golden Gate to begin work between the railroad shoofly and the Alameda Portal building.

A total of about 450,000 cubic yards of dredging was completed during the year.

The dredged trench for placing the precast tube segments ends in Oakland 40 feet south of First Street. The trench will be 100 feet wide and 80 feet deep between Webster Street and the remaining portion of the 3-story reinforced concrete warehouse.

The bulkhead shown in the accompanying plate, "Bulkheads at Haslett Warehouse" has been designed and constructed by the contractor to protect the building from damage.

Wells to Be Installed

Pumping wells will be installed in the drainage rock in order to maintain a constant ground water surface level about 15 feet below mean sea level. The constant ground water level will minimize the possible loss of ground under the building footings from ground water erosion, and will provide a horizontal compressive force on the ground under the footings resisting ground movement toward the open trench excavation. The bulkhead was installed during the fall of 1960 and all work inside the building has been completed. The Port of Oakland is spending about $825,000 to remodel the building, and it is planned to move their main offices into the upper floors of the building. Restaurants will occupy the ground and top floors of the building.

Other noteworthy accomplishments not described include $200,000 worth of railroad track, pipe line, cable and wire relocation work by subcontractors and utility companies.

More information on the construction and placing of the tube segments will be given in another article at a later date.

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Engineering News-Record, Oct. 20, 1960, page 43, Graving Dock construction.

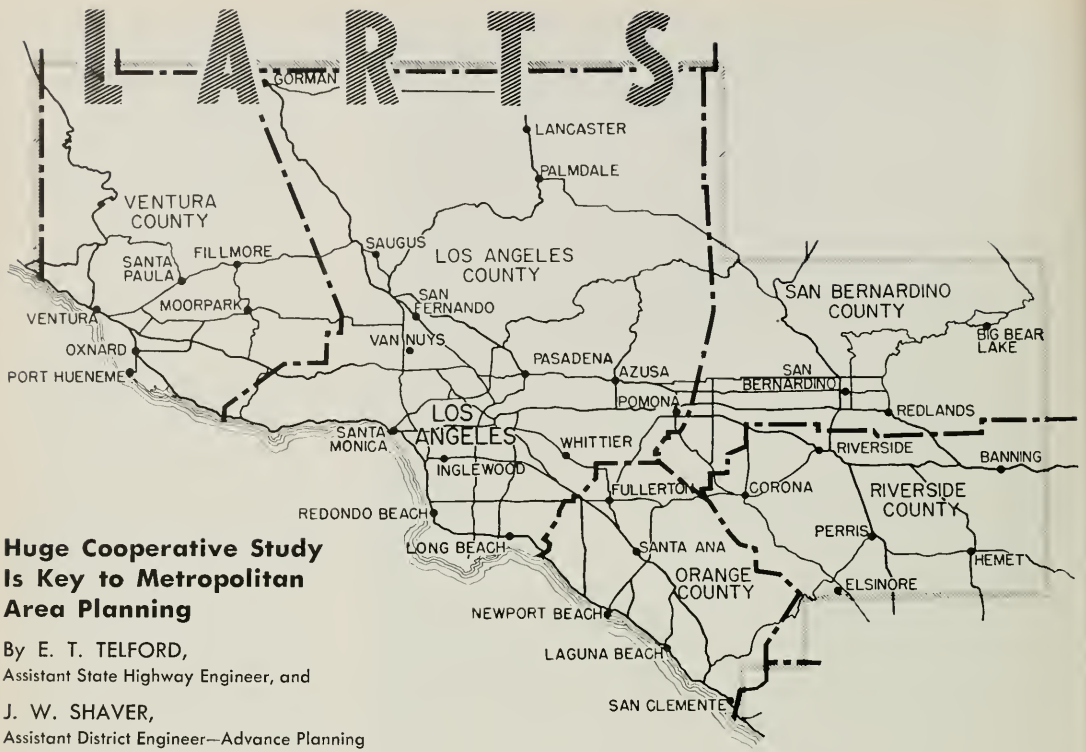
Western Construction, April 1960, unusual construction methods used.

Engineering News-Record, Oct. 8, 1959, page 59, contract bid prices.

Civil Engineering, April 1960, page 77—Tube design considerations.

California Highways and Public Works: March-April 1960—Work starts, page 11. November-Dec. 1959 — Navy Hanger Relocated. Sept.-Oct. 1959—Tunnel lighting, page 43.

Braking distances on winter road surfaces are in the order of 3 to 12 times as great as those of bare pavement.



Huge Cooperative Study Is Key to Metropolitan Area Planning

By E. T. TELFORD,
Assistant State Highway Engineer, and

J. W. SHAVER,
Assistant District Engineer—Advance Planning



ON JANUARY 30, 1960, Mr. Robert B. Bradford, Director of Public Works, State of California, announced the start of the Los Angeles Regional Transportation Study. He stated,

"Perhaps the largest-scale major cooperative State and local transportation study ever conceived is now in the making. This is the transportation study covering all of Los Angeles, Orange and Ventura Counties, and the westerly, highly populated portions of San Bernardino and Riverside Counties. We are talking in terms of 8 million people and 4 million vehicles now, and an estimated 15 million people and 8 million vehicles in 1980.

"In carrying out this study, the State will again rely heavily on the same type of Advisory Committee of local officials which worked so well with the SCR-26 Report (Freeway System) and is working so well now on the SCR-62 Study (City and County Street and Road Needs). We are asking the County governmental authorities to appoint people to this committee who will not only review and evaluate the progress of the study, but who will also serve as a source of ideas. In addition to the counties, we hope to have on the Advisory Committee representatives of the Metropolitan Transportation Engineering Board, the Automobile Club of Southern California, the Institute of Transportation and Traffic Engineering, and others, with the Automotive Safety Foundation also being called on once again to supply technical advice and a broad perspective based on its nationwide experience."

List of Members

As a result of the request of the State Division of Highways, the following members were appointed by their governing bodies and organizations to the Advisory Committee:

Allen S. Koch (Chairman) Road Commissioner, County of Orange

Hugo Winter (Secretary) Los Angeles Metropolitan Traffic Association

Milton Breivogel Director, Regional Planning Commission Los Angeles County

John L. Curtis Senior Transportation Engineer Metropolitan Transit Authority

Prof. Harmer E. Davis Director, Institute of Transportation and Traffic Engineering University of California

Joseph E. Havenner Director, Engineering and Technical Services Automobile Club of Southern California

A. C. Keith — County Surveyor and Road Commissioner County of Riverside

Merrill C. Lorenz — Director of Public Works, County of Ventura

Martin A. Nicholas — County Engineer County of San Bernardino

Lyall A. Pardee — City Engineer City of Los Angeles

Newton H. Templin — Road Commissioner County of Los Angeles

Fritz Zapf — City Engineer, City of Pasadena Metropolitan Transportation Engineering Board

Alan M. Voorhees, Traffic Planning Engineer, a representative from the Automotive Safety Foundation, together with representatives of the Bureau of Public Roads, are members of the Technical Advisory Group. The Bureau has approved this study for financial participation of Federal Aid planning funds.

A preliminary phase of this study actually started in December, 1958, when the Los Angeles City Traffic Department under S. S. Taylor, General Manager, in cooperation with the State Department of Motor Vehicles, mailed out over 3 million postcard questionnaires with the 1959 registration renewal form. The City Traffic Department received a return of 1,400,000 and are in the process of coding 350,000 of these postcard questionnaires which contain information about work trips and trips for other purposes, time and distance of travel, and days of usage.

Cooperating Agencies

The Los Angeles Regional Transportation Study is being conducted under the general coordination of the California Division of Highways with the cooperation of the Bureau of Public Roads, the five counties of Ventura, Los Angeles, Orange, San Bernardino and Riverside, 117 cities in these counties, and several public and private organizations associated with transportation. Its purpose is to determine the transportation needs of the study area for 1960-65-70-75 and into the future for use in local and regional integrated transportation planning. This will be done by relating the movement of persons and goods to land use, utilizing modern high speed computers, and the latest land use and traffic model techniques.

Working within the framework of community and area-wide planning, the land use model will be used to project and distribute changes in population, employment and land development. The derivation of this model depends on the collection and analysis of data which can best be related to area growth, such as: distribution of past, present, and proposed land use, employment, population, land costs, topography, and the availability of water, sewers, highways, etc.

The traffic model is based on inventories of transportation facilities, determination of travel characteristics, and factors of land use that give the greatest accuracy in predicting travel and trip production. This model converts the information derived from the land use model to person and vehicular trips and assigns these trips to the network of freeways, major arterials, and collector roads by five-year intervals into the future.

Planning Assistance

The LARTS Study is not only designed to give greater insight into the interrelationships between land use and transportation; but it also offers local and regional authorities the planning tools for objective evaluation, in terms of transportation needs, of their present and future planning—both as to its effect on local areas and on the region as a whole.

This study is intended to be a continuous planning operation utilizing new data at regular intervals and leading to greater refinements of study techniques. Although the first two-year phase of this study will be oriented toward vehicular travel, it is planned in subsequent phases to include the possibility of other modes of travel and any other likely innovation in the movement of people and goods.

As the study progresses and its potentialities for local as well as region-wide coordinated planning becomes evident, engineers, planners, public officials, and others will not only lend support, but will share a common realization that significant progress has been made toward a well-founded



LARTS Advisory Committee meeting in progress. Committee members seated around the table from left to right are: A. C. Keith, John MacDonald (substituting for Joseph Havenner), John Curtis, Milton Breivogel, Allen S. Koch (chairman), Hugo Winter (secretary), Fritz Zapf, Irving Mohar (substituting for Newton Templin), Lyall Pardee, Eugene Tidwell (substituting for Martin Nicholas), and Richard Sheridan (substituting for Harmer E. Davis). Standing left to right are George Hill, District Engineer, District VII, and John Shaver, co-author of the accompanying article. Seated on the right are Herschel Brown, Los Angeles City Engineering Department and Gibson W. Fairman, Planning Engineer, District VII.

MAR 2 1961



Highway Planning Survey personnel interview outbound traffic for the LARTS study just narth of Ventura on the Pacific Coast Highway.



Past cord questionnaire coding room in the State Division of Highways Building in Los Angeles. Reviewing the work in the foreground (left to right) are A. L. Hutchison, Assistant General Manager; Jim Hardy, Senior Traffic Engineer; and Charles Koch, Traffic Engineering Associate, all of the Las Angeles City Traffic Department.

plan of integrated transportation facilities for the greater Los Angeles area.

The existing pattern of the movement of vehicles, people and goods will be derived from five Origin and Destination Surveys:

1. The postcard questionnaires which were mailed with the 1959 motor vehicle registration renewal forms. Data from these cards furnish most of the details related to patterns of movement.

2. Limited Home Interview Origin and Destination Survey. This survey was conducted in the summer of 1960 by the Division of Highways. It was designed to furnish household and travel characteristics such as: type of dwelling units, number of registered automobiles per dwelling unit, the mode of travel used by occupants of dwelling units, trip length distribution, proportion of trips by purpose, number of trips per car, etc.

3. Office Interview Origin and Destination Survey of "for hire" trucks. This survey will establish the pattern of "for hire" truck movements and the commodities carried. The field work for this survey was completed in the summer of 1960 by the Division of Highways.

4. Postcard Questionnaire Origin and Destination Survey of regular commercial vehicles. This survey was conducted during September and October, 1960, by the Division of Highways. Questions are the same as those asked in the "for hire" truck survey.

5. External Cordon Origin and Destination Survey. Roadside interviews of outbound traffic were conducted at 17 cordon stations on the perimeter of the LARTS Study Area. This survey, conducted in the summer of 1960 by the Division of Highways, will furnish data on travel in and out of the study area.

Although the field work is complete on these surveys, there still remains a tremendous task of coding, key punching, and analyzing these data so that they can be integrated with other phases of the study.

Preparation of Maps

Another sizable job in connection with the inventory of travel is the preparation of maps and tabulations showing the 1960 average daily travel

on all freeways, major arterials, and collector streets which will be used in the network for traffic assignment. These traffic volumes will be obtained from various City, County and State traffic count records or from previous studies such as the SCR-62. These 1960 ADT's will be used to test the study methods by comparing them with 1960 traffic assignments made by the computers.

Public transit usage will be obtained from mass transit companies in the area, as the LARTS Study does not intend to duplicate work that has already been completed for this mode of travel.

Land use information will be of major importance for the completion of the LARTS Study. For analysis purposes, these data must be recorded in a uniform and systematic manner for the entire study area. The job of co-ordinating the collection of land use information is under the general direction of Milton Breivogel, Director of Los Angeles County Regional Planning and a member of the LARTS Advisory Committee.

The first steps to standardize procedures of data collection were taken by the temporary Land Use Criteria Committee headed by Joseph A. Mellen, Planning Director of the City of Glendale. This committee, in co-operation with the LARTS staff, determined what land use data were needed and developed an instruction manual and a set of forms on which this information could be recorded.

Land Use Form

A four-page land use summary form was developed and is being distributed to all the planners in the five counties and 117 cities in the LARTS area. The planners will be asked to complete these forms for each 1960 census tract in their jurisdiction. Since Ventura County is not tracted, some system of planning areas will be developed. The large census tracts in the other counties will also be split into suitable planning areas. The forms as transmitted will include:

(1) Present land use inventory for each of the 1960 census tracts using seven major categories such as residential, commercial, community service, industrial, transportation, military



Survey Interviewer I. B. Manahan (center) interviews truck driver William Kiner. Lending assistance (right) is Gene Thuesen, sales manager of Knudsen Creamery.



A home interview for origin and destination information being conducted by Survey Interviewer John Crisp (left) in the home of Mr. and Mrs. Levring and their two daughters Judy and Janet.

installation, open land. These categories and land use groupings are primarily oriented toward traffic generation and land use predictions. This will be used with other data to establish population and employment densities, traffic generation, and other factors necessary in the allocation of traffic over the entire study area.

(2) Special land use information such as the ultimate development of the 1960 open usable land and the historical data for 1950 open usable land indicating type of land use conversion taking place, and listing redevelopment projects and any special high-traffic generators.

(3) Residential land characteristics for two time periods, 1950 to 1955 and 1955 to 1960. The characteristics requested for these periods include water, sewer, highway, public transit service, and an indication of whether or not the vacant land was suitable for mass development. In addition, information is requested on the 1960 average vacant residential land cost per acre, and the average topographic conditions.

(4) The final page will require information in regard to industrial land characteristics existing between 1955 and 1960. The information requested includes highway, water, sewer, rail, transit service, and the average 1960 vacant industrial land cost and topography.

The LARTS staff has obtained from the State Department of Employment 1960 employment data by census tracts. Historical employment data for community labor market areas will come from the same source and others such as the US Census of Manufacturers, US Census of Business and Sales Management Surveys. Information is also being obtained on motor vehicle ownership distribution from special surveys made by the Times-Mirror Company and the Division of Highways. Current information will also be available by census tracts from the 1960 US Census.

Computer System Installed

The Highway Planning Survey Department in Sacramento has just acquired an IBM 704 magnetic tape data processing system, which will be used in processing the above land use and traffic data. By mid-1962 this computer system is expected to develop the following quantitative and qualitative results:

(1) A complete pattern of the movement of people and goods for the entire study area for the years 1960, 1965, 1970, 1975 and 1980. The pattern will show travel desires between census tracts (zones).

(2) A complete analysis of vehicular transportation needs by the same five-year intervals on a local and region-wide basis.

(3) The Average Daily Traffic volumes for the years mentioned above for the freeway system, and major arterial and collector streets.

(4) Objective evaluations for the same years in terms of transportation needs, of present land use and future land use plans proposed by the city and county planners. These evaluations by five-year intervals will be tools for planning on a priority basis.

(5) A data summary of population, employment, motor vehicle ownership, etc., and an inventory of land use for every local community by census tracts. These data will be punched on IBM cards by the Division of Highways and each local community may request a duplicate deck for its own planning purposes.



The LARTS study being explained to local officials in Orange County by Gibsan W. Fairman, District Planning Engineer, District VII.

These are some of the qualitative results expected by mid-1962:

1. A greatly increased understanding on the part of planners and engineers of the interrelationships between land use and transportation planning.
2. A greater appreciation of the value of well-coordinated, systematic, uniform data collection.
3. A better understanding of the factors influencing residential, industrial and commercial land development.
4. A better insight into patterns of growth on a local and region-wide basis.
5. An increased awareness of the effect each community's planning has on surrounding communities and the region as a whole.

... Continued on page 68

Guthrie Reappointed, Erreca Named to C.H.C.



JAMES A. GUTHRIE



JOHN ERRECA

Governor Edmund G. Brown has reappointed James A. Guthrie of San Bernardino to a four-year term on the California Highway Commission and has appointed John Erreca of Los Banos to a four-year term, succeeding Chester H. Warlow of Fresno.

Both appointments were effective January 15, 1961.

Guthrie was first appointed to the Commission by Governor Earl Warren when it was established in its present form on September 14, 1943, and was reappointed by Governor Warren in 1945, 1949 and 1953, and by Governor Goodwin J. Knight in 1957.

He is a widely known newspaper publisher, and has been associated for many years with the San Bernardino *Daily Sun* and *Telegram*, of which he is the editor and president.

He has also carried on a broad range of civic improvement activities in his home community and — especially in the field of good roads — statewide. He is a member of the board of directors of the California State Chamber of Commerce and has served on its highway committee for a long time.

At the Commission's January meeting, Guthrie was elected to serve as vice-chairman for 1961. He has been vice-chairman in previous years.

Long-time City Official

Erreca, the new Commission member, has also achieved a distinguished reputation in civic service, especially in the Los Banos area, where he is a farmer and cattleman. He has been a member of the Los Banos City Council since 1938 and the mayor since 1944. Upon his appointment to the Highway Commission he resigned from the City Council.

In 1953 Erreca was elected to the board of directors of the League of California Cities, and served as president of the League in 1959. Last year he was chairman of the League's highway committee.

He is a past president of the Merced County Livestock Association and president of the board of directors of the Merced County Spring Fair.

Warlow's service on the Commission, which ended in January, extended over more than 17 years. Like Guthrie, he was a member of the original 1943 Commission.

SIGN ROUTE 68

The Salinas-Monterey Highway has been designated State Sign Route 68, it was recently announced by State Highway Engineer J. C. Womack.

This route, previously unposted, extends from Sign Route 1 in Monterey to U.S. 101 in Salinas. The new designation will be effective as signs are posted.

Womack Is Elected To A.A.S.H.O. Post

State Highway Engineer J. C. Womack is serving as first vice-president of the American Association of State Highway Officials for 1961. He was elected to the office at the Association's 46th annual meeting, held in Detroit in December, 1960.

Womack also continues as a member of the executive committee of AASHO, on which he began serving last year.

The Association elected Dwight H. Bray, chief engineer of the Kentucky Highway Department, as its president for 1961, succeeding David H. Stevens, chairman of the Maine State Highway Commission.

Advisory Committee Named by Governor

Governor Edmund G. Brown has appointed a three-man Advisory Committee on the planning of a Southern Crossing for San Francisco Bay. The committee plans to meet quarterly, starting in February.

Members of the committee are State Director of Public Works Robert B. Bradford; John J. Purchio of Hayward, a member of the California Highway Commission; and William Roth of San Francisco, a member of the California Toll Bridge Authority.

The Governor said the committee's functions will be to bring together the reports on progress in planning an additional crossing; to suggest additional studies or investigations; and to hold public hearings and meetings. It will also be very much interested in increasing public participation in planning for the additional crossing.

Studies for a Southern Crossing have been made by the Department of Public Works over a number of years, and will continue.

The State Division of San Francisco Bay Toll Crossings will advertise for bids shortly for strengthening the upper deck of the west bay portion of the San Francisco-Oakland Bay Bridge.

Remainder Parcels

Cooperative State-B.P.R. Appraisal Study Underway

A REPORT OF THE LAND ECONOMIC STUDIES SECTION, RIGHT-OF-WAY DEPARTMENT

By JAMES R. SMITH, Headquarters Right-of-way Agent

THE STUDY of properties from which freeway right of way has been acquired, after the freeway itself has been constructed and opened to travel, is called remainder parcel research. Presently, twenty state highway departments across the nation in cooperation with the U.S. Bureau of Public Roads, are actively engaged in such studies as a part of their current right of way and land acquisition programs.

These studies seek to test the efficiency of right of way appraisal efficiency by continuously evaluating freeway effects upon abutting properties. Changes in land value and land use in the "after" period, as revealed by sales of and developments upon remainder parcels, are the principal means by which both freeway effects and appraisal efficiency are subsequently evaluated.

Logical Adjunct

The development of empirical data on remainder parcels is a logical extension of the right of way appraisal process. An appraiser finds, for example, that whenever the right of way parcel he is evaluating is only a part of a larger parcel, he must ascertain and assess the damages, if any, accruing to the remainder because of the acquisition and the construction thereon of the highway improvement. It is also necessary, he finds, to determine how much the remainder will be benefited, if at all, by the construction of the new highway.

And it is in the actual identification, measurement, and further application of these latter elements—damages and benefits—that the right of way appraiser encounters the vexing problem to which remainder parcel analysts have addressed themselves. For it is in the *partial acquisition* situation that the need is evident to determine if an abutting freeway is going to produce a significant effect—to determine exactly what it is going to be like to live or do business alongside, such a facility.

Essentially, the problem becomes one of estimating the effects of both the acquisition and the freeway upon the market value of the remaining parcel (remainder), generally answering for the owner the question: "*In an 'open market' sale, would I receive proportionately more, the same, or less for my property after right of way acquisition and freeway construction than I would have received had this project never been proposed?*"

To answer this query, case studies are made of parcels adjoining a completed freeway—parcels from which a part was purchased some time in the past. As the remainders sell and as they are developed, they become directly helpful as examples to be studied in assessing *proposed* freeway effects in connection with current appraisals.

Finding out what is likely to happen to a particular kind of property in the future is therefore largely a problem of first looking to the immediate past, i.e., finding and studying similar parcels to which the whole thing has already happened. Because these remainders are now "freeway abutting" parcels, their post construction history may be taken as a reflection of, among other things, *freeway effects*.

The uses to which the parcels are put in this "after" period; the degree to which they drop or increase in price, or hold their value relative to parcels away from the freeway; the extent and nature of investments in them—all of these major facets of the remainder parcel become the keys to a more realistic evaluation of actual freeway effect. And thus it can be seen that not only would such remainder parcel facts provide a property owner with the bases he needs for decision making and planning, but they could as well provide the right of way man with sound data so that he might conscientiously fulfill his "just compensation" appraisal obligations.

Time Needed

The mere wish on both an owner's and a right of way man's part for factual substantiation of remainder parcel freeway effects was in itself not enough to bring about any wide use and acceptance of case study remainder analysis. The facts first of all needed to be in existence; this meant that a significant number of miles of completed freeway had to be in operation long enough for remainders to adjust, react, and thereby bring into being the basic fact and data fund from which subsequent projections could be realistically made.

Specifically, time was needed for remainder parcels to sell in the open market after freeway completion. A careful study of these sales, it was premised, should reveal whether or not the remainders had done as well as they would have had the freeway never been constructed, and thus should clearly indicate the freeway's damaging or benefiting potential in those instances.

Time for developments to take place upon freeway abutting remainders was also needed. Whether they were subsequently offered for sale or not, the nature and extent of investments in these parcels was recognized as another damage or benefit measure sure to be of direct help. And again, whether culminating in a sale or not,

land use changes induced by the adjacent freeway needed time to become evident, although in this area the actual time needed frequently turns out to be short indeed, "for example, farm lands being developed industrially far in advance of, but anticipating, a proposed freeway".

The present national interest in remainder parcel research, which is at an all-time high, is also an outgrowth of the Federal Aid Highway Act of 1956—and to the greatly heightened nationwide freeway program that legislation made possible. If for no other reason, the need for such facts would become increasingly apparent as a state's right of way program greatly increased in scope and complexity and its right of way appraisers found themselves faced with a workload requiring, if possible, even more appraisal competency and thoroughness. Encouragement by the U.S. Bureau of Public Roads of right of way oriented research which would assist in effective implementation of the expanded highway program, thus almost inevitably followed.

Bureau Participation Explained

Generally speaking, the role of the Bureau in state highway department remainder parcel studies largely parallels its overall role under the Federal highway program. Federal funds under that program are available to state highway departments for various kinds of highway research. Studies of freeway right of way appraising—particularly the determination of damage and benefits elements in the partial acquisition situation — were quickly recognized as fruitful areas for research, and they have received increasing emphasis. States have been encouraged to undertake such studies, and most, if not all, of those engaged in remainder parcel research are utilizing Federal funds to finance all or parts of their right of way studies. That portion of the current California program dealing with damage and benefit case study analysis is also presently being financed with Federal planning survey funds.

Financing is, however, but one facet of the overall role assumed by the Bureau of Public Roads. From their position at what is actually a kind of hub



Often much can be learned about freeway impact by simply observing the developments which occur on remainder parcels. In this example, a vacant, irregularly shaped remainder as it looked in 1954 is outlined on the upper photograph. The neighborhood was an older single and multi-family residential one through which the Hollywood Freeway was constructed (at the right and rear of the parcel). When the lower photo was taken in 1958, a new and modern apartment house had already been constructed to fully utilize the site. Part of the landscaped freeway improvement for which right of way was originally acquired is shown at the right. (Note that owner had telephone pole on Harold Way moved from the approximate center of his parcel to its right corner.)



of nationwide effort in the field, Bureau specialists have been able to stimulate the program by facilitating a very desirable interchange of procedural and other data. The value of this kind of coordinating activity is quickly apparent. As a result of it, for example, the possibility of developing a national "bank" of empirical data by which appraisal theory may ultimately be tested and evaluated becomes highly encouraging, since uniform reporting and uniformity of data become easily possible.

Recently, Bureau specialists have begun the formidable task of organizing for machine tabulation and analytical programming, and significant progress leading to the development of a manual of procedure in this area is currently being made. Thus the logical step from relatively simple documentation at the appraisal level, to complex testing of hypotheses at the theoretical level, has already been taken.

California Program

From time to time since the Pasadena Freeway (then Arroyo Seco Parkway) was constructed in 1940, California right of way agents have been compiling and utilizing case studies of freeway adjacent parcels in their day to day right of way work.

Practically, these early case studies were of tremendous appraisal significance; they were the first items of empirical data available regarding freeway effects. As such, they were weighed and evaluated by both appraisers and landowners, and became the basis for countless subsequent investment and development decisions. Generally, the data showed *positive* freeway effects and benefits, and with relatively few exceptions, the validity of even the earliest decisions predicated on the freeway as a salutary factor were in fact borne out by subsequent events. Thus in the area of practical use, even the few cases available in early years proved to be accurate and realistic appraisal tools.

Theoretically, however, these initial data were limited by something of a "built-in" deficiency – they were almost by definition, limited in number, in scope, and in applicability. Thus, since it could not be shown that they did in fact truly represent *all* remainders over any specific time period, ready acceptance of them was impaired, and they were subject to the basic criticism that perhaps they might be the exception rather than the rule. Moreover, since they were limited, their actual usefulness was restricted as well, in the sense that in any particular appraisal problem, the chances of finding a really close fit to the problem at hand were proportionally small.

Taking first things first, then, it was quite early premised that California remainder parcel studies would clearly have to:

1. Include the analysis of each remainder along every freeway completed within at least the preceding three years.
2. Be on a continuing basis so that, at regular intervals, all remainders along any given freeway would be checked for sales and developments.

Only when these prime requisites had been met, it was premised, would it be possible to begin to utilize effectively the theory-making potential of remainder parcel data, as well as utilize its practical advantages and applications.

Remainder Parcel Concept

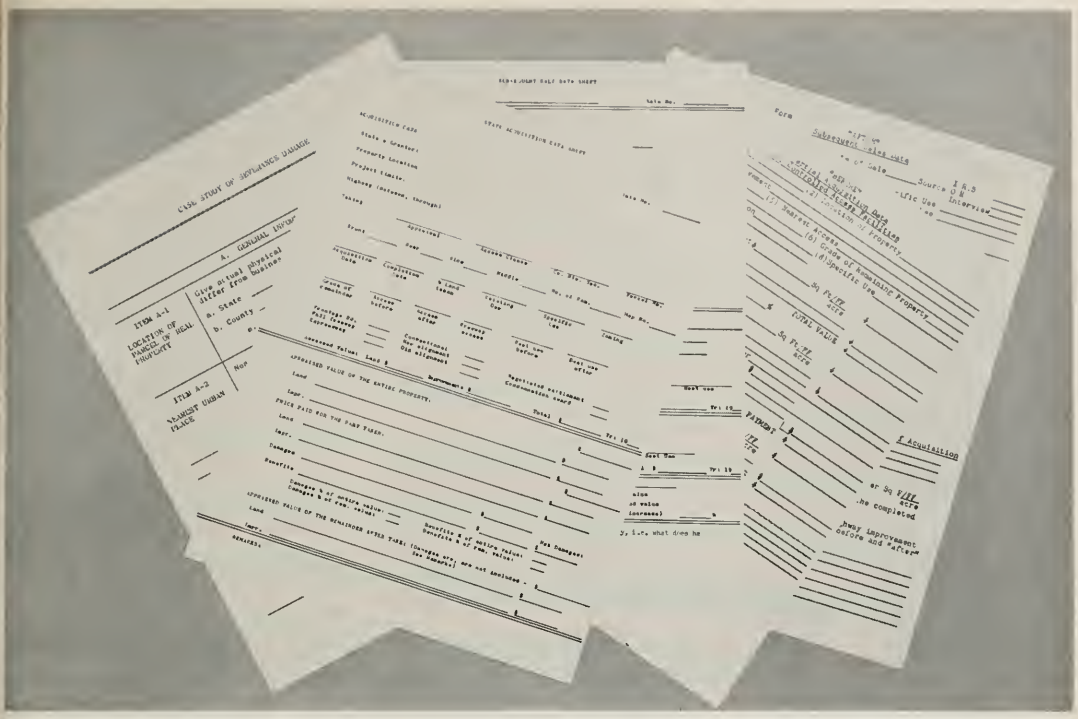
As would be expected, many of the early statements of the need for and purposes of remainder analysis came from California, and reflected California freeway experience. The subsequent emergence of right of way studies reflected the conditions already noted as being necessary to stimulate and thereafter permit such research, i.e., completed freeway mileage, an expanding freeway right of way program, an active and dynamic real estate and economic environment, etc., which conditions had existed in this state for a relatively long period. Even in California's earliest freeway days, the need for remainder parcel facts had already begun to make itself felt. Shortly there followed the concomitant stimulus to do something to satisfy the needs, and the earliest starts at this kind of analysis were made. As a result, the remainder parcel concept has been in existence for some time in the state and may be briefly outlined. Presently it constitutes the rationale for the current land economic study effort.

Remainder studies would clearly be useful in determining if a particular freeway imposed a damaging or beneficial effect upon a particular property. As has already been noted, the evaluation of the sale or development of a remainder in the light of activities similar but uninfluenced areas, should quite accurately reveal freeway effects, or more precisely, the effects of the construction of the freeway improvement itself. The nature and extent of activity on the remainder, after completion of the new highway, is broadly seen as reflecting not only the general interplay of economic forces, but the influence of the abutting freeway as well. When by means of control area comparison the general influencing factors are removed, the result may be reasonably attributed to the abutting freeway.

Reference to Original Unnecessary

In such an approach, reference to the original holding of which the remainder was formerly a part is unnecessary, and contributes little if anything to the analysis. In effect, the remainder is viewed as an "entire" parcel as it stands, and the question that sales analysis would want to answer, for example, would be: "Would this remainder (now simply a property adjacent to a freeway) sell for the same amount if it were *away* from the freeway and its influence?" The answer would thus help only to solve the problem of determining the effects of the *freeway construction itself;* and attempting to relate back at any point in the analysis to the original, pre-freeway holding would probably add little but confusion.

Largely, it can be seen, remainder parcel study in this sense is similar in concept—if not identical—to studies of *any* kinds of freeway-abutting parcels, e.g., "intact" properties from which no right of way was ever acquired, and which are perhaps adjacent to a new freeway now occupying what formerly was a neighbor's land. Thus the remainder parcel—to be singled out for special study—must be



Typical reporting and analytical forms for the compilation of remainder parcel data. Such forms include a complete "before and after" history of each property and its highway environment, and provide the basic data source from which freeway and right of way acquisition effects are inferred.

capable of making some other significant contribution over and above that of "freeway effect," and this is very clearly the case. *Actually, to conclude that remainder studies are a measure only of this one element—freeway effect—is to fail to grasp the full right of way appraisal context involved, and thus actually to fail to fully develop their appraisal and investment potential.*

Effects of Severance

Perhaps the significant element in the entire partial acquisition process is the determination by the appraiser of the effects, if any, of the *severance of the part sought to be acquired from the remaining property*. In addition to the effects of the construction of the freeway itself (freeway effects) this latter element must be considered as well in ascertaining the nature and extent of damages and benefits, if there in fact be any. It is immediately apparent that remainder parcels actually offer the *only* opportunity to study the effects of the *acquisition* itself, and it is primarily because of this that they are being studied. The entire context in which the original right of way appraisal was made thus becomes the unique reference for remainder analysis, and the original valuations and assumptions become both the bases for testing as well as the items to be tested.

An additional byproduct emerges. As has already been noted, every partial acquisition situation requires an appraisal of the presence and amount, if any, of damages and benefits attributable both to the freeway and the acquisition. Decisions on these factors *are* made in each such appraisal, and the amounts which remainder owners subsequently accept reflect the damage and benefit assumptions so developed. It thus becomes apparent that subsequent sales of and developments upon these "damaged or benefited" remainders become excellent indications of the validity of the original appraisal assumptions, over and above any light they may shed upon freeway effects as such.

District Effort

To carry out the California program, Senior Right of Way Agents in charge of the appraisal function—or sections—within each of the 11 highway districts have been given direct supervision over remainder parcel studies. These men have in turn assigned one Associate Right of Way Agent full time to the project, with the assistance in many districts of one or more Assistant and Junior Right of Way Agents as well.

These analysts are carrying out the following study sequence:

1. List completed freeway projects and all of the remainders adjacent thereto.

2. For every project, carry out a systematic parcel by parcel check of each remainder to determine:
 a. Chain of ownership since highway acquisition and development, including sales and sales data where changes in ownership have occurred.
 b. Extent and sequence of development of remainders, such as physical improvements, changes in use, etc.
3. Combine remainder parcel sales into groups of comparable units for the purpose of comparison with control data.
4. Locate control areas, which will:
 a. Contain properties being put to identical uses to those under study at the time of right of way acquisition.
 b. Be similar in all significant environing conditions to the area in which the remainders under analysis are located.
 c. Have followed a similar trend and exhibited similar developmental patterns and characteristics to those of the remainder areas, up to the time of right of way acquisition.
5. Determine by control area and study parcel comparison whether the remainders have done as well as, better, or worse than freeway-removed properties whose trends they would normally have shared had the freeway not been injected onto the scene.

With this information, parcel by parcel analysis is completed—at least for those remainders on which there has been some activity since freeway construction. Those which have not sold or have not been developed, are held for continuous future checks until they either become active and can be studied, or are inactive for so long that meaningful comparisons can no longer be made. Once on such a continuous basis, the program virtually assures the relatively early availability of the mass of remainder parcel data needed for realistic theory testing.

As valuable as these overall data evaluations will be, however, it is in the specific case-by-case comparison where this approach will develop its full, working potential. At this level, appraisers are seeking first of all not to find what *properties* are apt to do, but how well a *particular property* is likely to fare, and remainder parcel cases are uniquely suited to directly provide the answers. Thus the pinpointing of effects in a manner that will satisfy the property owner that his individual problem and parcel are receiving the full, factual measure of consideration, becomes the worthwhile promise this new era of analysis can continuously offer.

Survey Shows Cars Move At Faster Pace

Sacramento, December 30—Continuing a post-World War II trend, motor vehicles traveling state highways in California are moving at an appreciably faster pace in 1960 than they did in 1958, the Division of Highways reported today on the basis of a recent survey.

On the open road, average speeds of all vehicles increased 1.7 miles an hour from 52.8 in 1958 to 54.5 in 1960. Passenger cars on the average speeded up from 54.1 miles an hour to 55.7, two-axle trucks from 48.0 to 49.8 and three and more axle trucks and combinations from 47.0 to 48.6 miles an hour. Average speed of buses went up from 56.1 to 56.5 miles an hour.

Increase in the average speed of passenger cars on two-lane roads was 1.5 miles an hour (from 52.6 to 54.1) and on freeways 1.9 miles an hour (from 55.5 to 57.4).

The surveys were made in October of both years. In 1960, a total of 50,016 individual observations were made of the speed of traffic at 146 selected locations. The observations were made in hours of daylight during periods of clear and dry weather and free-flowing traffic conditions. The selected locations were on straight roads in areas away from the influences of speed zones, roadside developments and other physical controls which might affect the speed of traffic.

It was noted from previous years studies that except for 1958, speeds have risen at a fairly uniform rate during the post-war years. The average speed reported in November 1945 was 45 miles an hour.

BPR Revises Manual On Traffic Devices

New national standards for traffic signals, signs and markings have been approved by the Bureau of Public Roads, U.S. Department of Commerce.

The new standards are to be found in a revised manual drafted by the National Joint Committee on Uniform Traffic Control Devices. The committee is made up of representatives of the American Association of State Highway Officials, the Institute of Traffic Engineers, the National Committee on Uniform Traffic Laws and Ordinances, the American Municipal Association, and the National Association of County Officials.

G. M. Webb, Traffic Engineer of the California Division of Highways, is a member of the national joint committee. He has also served as chairman of its subcommittee on markings and as a member of its subcommittee on signs.

First written in 1936, the manual has been revised periodically since that time. The newest edition includes for the first time specific standards for expressway signing, a major section on signing and marking for construction and maintenance operations, and a brief treatment of civil defense signing.

"As a matter of policy the Bureau of Public Roads proposes to use its authority to approve, for the Federal-aid highway systems, only such traffic control devices as will conform to the new manual," a BPR announcement said. A reasonable time following the issuance of the revised standards will, of course, be allowed for the gradual replacement of any existing installations that may be made obsolete by the new manual.

Copies of the manual will be available from the Government Printing Office for general distribution in 1961. Publication details have not been announced.

Culvert Life

New Test Methods Estimate Life Expectancy of Pipe

By JOHN L. BEATON, Supervising Highway Engineer and
RICHARD F. STRATFULL, Associate Materials and Research Engineer

MANY types of materials have been used for the small structures needed to carry water beneath highways and railroads. Such materials as wood, brick, stone, glazed and unglazed clay pipe, cast iron and steel pipe have been used for over a century. In recent years, however, the majority of the culverts under State Highways have been constructed from either concrete or corrugated metal pipe.

The use of metal for culverts has both advantages and disadvantages. The modern corrugated types are relatively light to handle and offer a degree of flexibility over yielding foundations. (Note right photo in Figure 1.)

However, all steels and iron presently used in corrugated metal pipe production are subject to attack from ground water or atmospheric elements, and it has been obvious for many years that there is a considerable variation, as illustrated by Figure 1, in the life of metal culverts. Studies show this variation to be caused primarily by environment. Up to recent times, however, no objective means has been available for evaluating a proposed culvert site insofar as the environment may affect the service life of a metal culvert.

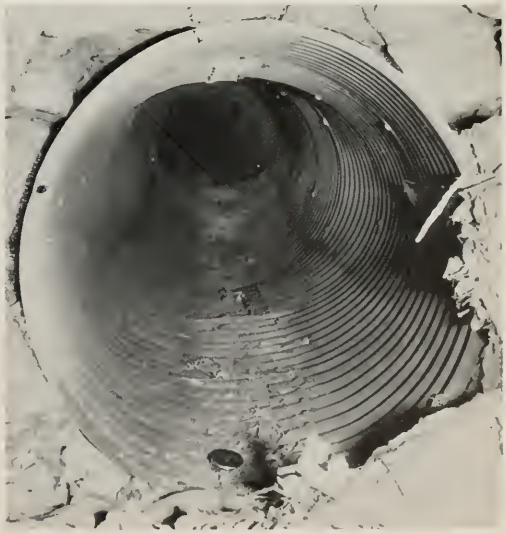
Culvert Replacement

Since the replacement of a culvert can be expensive and also can seriously disrupt traffic service, it is important that the designer have as much pertinent preliminary information as can be obtained within limits of reasonable cost and time, so as to determine whether (1) plain galvanized steel pipe will have a service life commensurate with that of the alignment, (2) protective measures might be desirable, or (3) structures of other materials should be used. He has available fairly adequate hydraulic and foundation data; however, knowledge concerning the effect of environmental factors on the life of culvert material heretofore has been incomplete.

As a result of studies and investigations at various periods during the past 35 years, the Materials and Research Department has evaluated a total of more than 12,000 corrugated metal culverts in the State of California. In general, these various culvert research projects have led to the conclusion that the best criterion for estimating the life of a metal culvert in a particular location is the service life of an existing pipe. However, not all new highways are constructed in locations where metal pipes have been in place for a sufficient length of time to be used for this purpose. With the increasing rate of highway construction in new locations, it is obvious that there is a need for a comparative test method that will evaluate the relative aggressiveness of the environment sur-

FIGURE 1. *Two corrugated metal pipe culverts, each 30 years old but in different locations. The pipe at the left was subject to carrasive flow which has remaved the invert. The pipe at the right was installed in an area which is relatively non-carrosive.*





rounding a culvert site prior to the placement of the pipe.

Any such method must, of course, take into account the environmental factors that cause or influence corrosion. A test method based on such factors is now in use by the Division of Highways.

Causes of Corrosion

In the most simple terms the cause of corrosion of metal culverts is moisture. However, the presence of moisture does not necessarily imply that the corrosion will be rapid, as the rate of corrosion depends upon the frequency with which moisture contacts the culvert. Corrosion is also influenced by the types and quantities of aggressive salts in the waters.

In a 1925 study by the Materials and Research Department it was found that when the average annual rainfall increased from 10 to 80 inches per year, the average life of metal culverts decreased by about 65%. One of the results of this study was an indication that the magnitude of the annual rainfall could be used to predict the corrosion rate. However, it was also observed that in areas of equal rainfall there were extreme differences in the rates of corrosion of individual culverts. It was apparent that factors other than relative amounts of rainfall were involved and needed to be investigated.

During a 1955 investigation in the northwestern section of the state, it was observed that when a certain type of soil bacteria was found at a culvert location the corrosion rate of the culvert was rapid. The presence of these bacteria was indicated by hydrogen sulfide gas in the soil. However, among other variables the propagation of these bacteria required that the soil be relatively flooded with moisture so as to restrict the ingress of air. It is therefore apparent that the presence of anaerobic bacteria is limited to areas of high rainfall or ponded water conditions and is of minor importance in many geographic areas of the State.

Influence of Solts

There are numerous kinds of salts in soils or water which can affect the corrosion rate of culverts. For instance, it is well known that the salts



Bituminous-coated corrugated metal pipe is inspected prior to shipment.

in sea water will result in rapid corrosion of steel. Also, the salts in "alkali" soils, effluents from mines, and numerous other sources are highly corrosive to common iron and steels.

With these corrosive salts present, and other conditions being equal, the corrosion of steel will generally vary as the concentration of the salts. Normally, the greater the concentration of "salts" the more rapid the corrosion rate. This rapid corrosion rate is the result of two factors: (1) the influence of the chemicals in causing the steel to "dissolve" or corrode and (2) the flow of electricity which accompanies the "dissolving action" or corrosion of the steel. Thus the corrosion rate is influenced by the rate of flow of electrical current as well as by the presence of salts or other chemical compounds conducive to corrosion. A large electrical current will result in a rapid corrosion rate. For instance, a flow of one ampere of direct current can cause about 20 pounds of steel to corrode each year. It is therefore apparent that the electrical resistance of the soil or water is a factor bearing on the probable rate of corrosion; a low resistance indicates rapid corrosion and a high resistance indicates a reduced rate of corrosion.

The electrical resistivity of a soil or water is also a rough indicator of the concentration of salts in a soil. The lower the electrical resistivity the higher the concentration of salts. For example, sea water has a resistivity of about 50 ohm centimeter, "alkali" soils range from about 10 to 200 ohm cm and a clean sand is about 10,000 ohm cm. An "alkali" soil is one which is generally alkaline, i.e., having a pH greater than 7.0, and contains considerable quantities of exchangeable sodium or potassium salts. An "alkali" soil is considered to be corrosive, but an alkaline soil may or may not be corrosive. (Alkaline merely indicates that the soil has a pH number that is greater than 7.0.)

Influence of pH

In this study it was observed that when the average annual rainfall increased, the hydrogen-ion concentration or pH of the soil decreased toward the acidic range. A pH of less than 7.0 is acid and a pH of more than 7.0 is considered alkaline.) It is generally considered that, with other conditions being equal, the corrosion of steel is more rapid in an acid than in an alkaline solution. Therefore, the general tendency is for the corrosion rate of metal culverts to increase with increasing rainfall. This apparent relationship between rainfall and corrosion was observed when 5000 metal culverts were evaluated by this department in 1925.

However, not all soils that are in areas of the same rainfall will have the same pH or soluble salt content because the drainage, vegetation and usage of all soils are variable. It is therefore readily apparent that the actual value required for estimating culvert life is that of soil pH and not necessarily rainfall. The measured soil pH is a value which is the result of the variables affecting the land in a particular location, while rainfall can only be indicative of an over-all average condition.

Corrosion of Culverts

From the preceding it is apparent that the factors which exert the greatest influence on the corrosion rate of metal culverts are pH and resistivity. With the same pH, the corrosion rate would increase as the electrical resistance decreased. Or, in a very general way, with a soil or water of the same acidity or alkalinity, the rate of corrosion would in-

crease as the salt content increased. For the purpose of discussion we are assuming that resistivity is an indicator of salt content. A low resistance is inferred to represent a high salt concentration.

The relative influence of pH and resistivity on the corrosion rate of metal culverts is shown by Figure 2, which is drawn from field data accumulated throughout the State. On Figure 2 there are three variables: the time to perforation by corrosion of 16 gage C.M.P., the electrical resistivity, and the pH or hydrogen-ion concentration of the soils or waters.

On Figure 2 it will be noted that with a constant acid pH of 5.0 the time to perforation of a 16 gage metal culvert in 100 ohm cm soil would be less than 5 years. However, in an acid soil of pH 5.0 and a 5000 ohm cm resistivity, the time will be about 20 years. With an alkaline pH held constant at 7.5, the perforation time with a 100 ohm cm soil or water would be about 10 years, and at 5000 ohm cm the years to perforation would be about 55 years.

Sample Assumed Identical

With any such tests there will be differences between the culvert life as estimated from a soil or water sample and the actual life. One reason is that the sample that is obtained is assumed to be identical for the total time that the culvert has been in place, whereas it may or may not have been. Another reason is that a test method cannot include all of the many variables that can affect the corrosion rate. Some of these variables ignored in this proposed test are the dimensions of the pipe, frequency of flow, bacteria, vegetation, land use and the possible change in land usage. Even though these variable have not been included at this time, a statistical analysis indicates that the use of Figure 2 for estimating the years to perforation of 16 gage galvanized metal culverts should give indications within 12 years of the actual field life. Therefore, it is felt that this method is a useful tool for estimating service life at the present time.

The corrosion rate of metal culverts is described as the time to perforation for 16 gage galvanized culverts. The perforation time for a culvert with a metal thickness of a different gage is obtained by direct ratio. A metal with twice the thickness of 16 gage is assumed to last twice as long. It should be understood that the estimated years-to-perforation of a metal culvert does not necessarily mean that the culvert will then collapse or that its usefulness as a carrier of flow will cease. Instead, this period of years-to-perforation is considered as a common yardstick for all culverts. It is not considered that the arching action or erosion resistance of a fill is sufficiently substantial to warrant the disregarding of a perforation or the loss of a culvert invert, otherwise these factors should be considered in the mechanics of the original design.

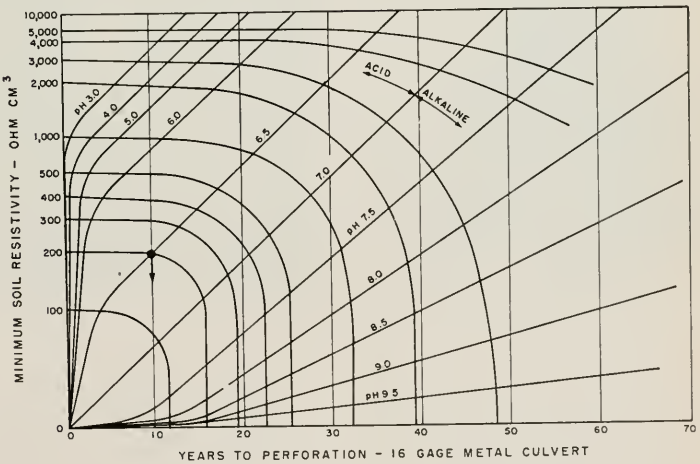
Generally, any laboratory test of this nature is a substitute for field data. Therefore, whenever possible, existing installations should be inspected and be given the greatest weight when considering the life of a metal culvert in a particular location.

Corrosion Test Method

The corrosion potential test method is relatively simple and rapid as the two factors to be obtained are the pH and the resistivity of the soils or waters. Naturally, whenever sampling is required there is a degree of judgment involved in the selection of representative samples.

The selection of the field samples is somewhat aided by the use of two portable instruments, the pH and resistivity meters. In general terms, the use of the pH meter, Figure 3, consists of gathering a small container full of water from a stream, inserting the electrode and pushing a button, or, if the pH of a soil is to be measured, about a tablespoonful of soil is mixed with about a tablespoonful of distilled water and placed in the small container. Then the pH electrode is inserted, and a button is pushed to read the meter. The entire operation of measuring the pH of a soil or water should not take more than 2 or 3 minutes.

As the time to perforation of a culvert depends upon the pH of the



EXAMPLE: Given, pH = 6.5 & Resistivity = 200 ohm cm^3
Then 16 gage CMP perforated in 10 years.
For a culvert metal gage of 12 multiply years by factor below. i.e. 1.8 x 10 = 18 years

Gage	14	12	10	8	6	2	0	000
Factor	1.3	1.8	2.3	2.8	3.3	4.3	5.0	6.0

FIGURE 2. *Chart for estimating metal culvert service life.*



FIGURE 3. *Measuring the pH of a stream which is used for estimating the perforation time of metal culverts.*



FIGURE 5. *Measuring the minimum electrical resistivity of soil at any moisture content. This resistivity value of soil is used for estimating perforation time of metal culverts.*



FIGURE 4. *Measuring the electrical resistivity of a soil in the field which is used for the selection of soils for further analysis.*

environment, sufficient pH measurements should be made to confirm that samples obtained for additional analysis will cover the range of any substantial variations in pH.

In an actual field survey the pH of all streams should be obtained at the site. For soils, either pH measurements or samples should be obtained in locations that differ in characteristics. For instance, samples should be taken or field pH measurements should be made when there are changes from no-vegetation to vegetation, changes in soil types or color changes of the soils, differences in land use, or distinct changes in the kinds of vegetation. These changes in the environment are most significant for the upstream side of a culvert site as it is the drainage water that can cause corrosion of the culvert. Also, samples should be obtained from the stream bed.

Soils May Alter

In many cases changes in the vegetation or color and types of soils may alter gradually over various distances. Therefore, in many instances visual observation of soils may cause a misleading feeling of confidence that a soil has not changed in characteristics. In addition, variations in amounts of corrosive salts in soils are impossible to detect unless they are crystallized on the surface of the ground. Therefore, the extensive use of instruments in the field is suggested.

As the electrical resistivity of soils can be considered as an indicator of

the quantity of salts, changes in the salt concentration can be detected with a field instrument. The use of the field resistivity meter (Figure 4) involves thrusting a steel rod into the ground and pushing a button to read the meter. With liberal use of this resistivity meter (it is recommended that the resistivity of soils at each culvert site be measured) a considerable area can be explored to determine where soil samples should be obtained for laboratory analysis.

Samples for laboratory analysis should be those that are significantly different in pH or resistivity. A "significant" difference is dependent upon (1) the average values for the sites in question, and (2) the magnitude of differences from this average that will significantly alter the culvert perforation time as shown on Figue 2.

Essentially, the laboratory analysis of soils (Figure 5) consists of adding water to soils to obtain the minimum resistivity at any moisture content. In addition, the pH of the soils is checked. For metal culverts the pH and resistivity measurements of waters obtained in the field are sufficient for design purposes and laboratory analysis is not necessary and applies only to waters and not to soils.

Pipe Cootings

As the corrosion of metal culverts is the result of aggressive soils or waters coming in direct contact with the steel, a membrane or protective coating that prevents moisture contact will increase the life of the culvert.

Retarding the corrosion of steel by a coating depends not only upon its quality and thickness but also on many variables such as abrasion, soil movement on the backfilled side of the pipe, moisture absorption, chemical stability and weathering. In estimating the additional life of culverts obtained by applying the commonly used asphalt coating on pipes, individual variables are of necessity expressed as an approximate average. This results in a degree of inaccuracy that depends upon the geographic area.

As an extreme illustration, in certain locations the asphalt in the invert of a plain asphalt coated pipe could be abraded by rocks and debris in one winter. Conversely, in low rainfall areas, the plain bituminous coating could remain and protect the culvert invert from corrosion for better than 15 years. Therefore, an estimate of coating life must be tempered by the environmental conditions at the proposed culvert site.

Statewide, the average result of inspecting coated metal culverts indicates that, in areas of frequent flow, a plain bituminous coating may protect the culvert invert from a corrosive flow for about 6 years. In areas where the corrosion is due to the soil backfill, a bituminous coating could add about 25 years to the life of a metal pipe. When a pipe is asphalt dipped and the invert is paved in locations of nearly or fully continuous flow, then it is estimated that this type of coating may add 20 years to the life of the pipe.

The asphalt coating on the majority of the existing pipes inspected during this study was an uncontrolled type of common commercial dip and undoubtedly resulted in erratic service life. The presently specified bituminous dip and lining material is superior in quality to that used formerly and should result in a greater increase in life than is indicated by this study.

Test Method Compared

As an indirect means of verifying this empirical method for comparing the aggressiveness of different soils toward steel, the data on the corrosion rate of steels embedded in soils throughout the United States published by the National Bureau of Standards in Circular 579, titled "Underground Corrosion," were correlated with the results obtained by using Figure 1.

This comparison of results from the test method developed in this study and the data published by the National Bureau of Standards, showed that the relative corrosivity of soils throughout the United States could be determined with a relatively high degree of accuracy.

For instance, if the depth of a corrosion pit in a piece of steel exposed for a number of years in an alkaline soil was used to estimated the weight loss of the same piece of steel, then the data obtained from a correlated Figure 2 would be half as accurate as estimating the weight loss by means of the pit depth. In acid soils the use of a correlated Figure 2 would result in the same approximate accuracy as using pit depth to estimate the weight loss of the same piece of steel.

Whether the measurement of the depth of pitting or the weight loss of steel buried in soils is a true measure of soil corrosivity is a matter of debate. However, the results from using the test method outlined in this study appear to be sufficiently accurate to predict the relative corrosivity of the soils in the United States as reported by the N.B.S. Test Method No. Calif. 643-A has recently been issued to the Districts and covers all test procedures involved in estimating the life of metal culverts. In the future design engineers can select the type of culvert with greater assurance that the economic life will be adequate.

AASHO Test Ends, Data Being Compiled

The initial phase of the biggest highway research project in world history ended November 30, 1960, when trucks rolled to a halt on the AASHO Test Road in Illinois.

The 25-month test was sponsored by the American Association of State Highway Officials to determine relationships between pavement performance and design under various test loads. Operations began in November, 1958.

Research engineers will spend the next several months analyzing some 200 million pieces of collected data and compiling final reports.

Cost of the test, about $27,000,000, was shared by all the states, the federal government, and industry. Field direction was handled by the Highway Research Board.

The eight-mile test road consisted of 836 concrete and asphalt pavement test sections and 18 short span bridges. Army personnel manned the fleet of 126 trucks which traveled some 17,000,000 miles on the test road loops. The trucks were operated 19 hours a day.

The test facility will be rehabilitated and incorporated in U.S. Interstate 80.

Staff Changes

Frank Balfour Retires; Hess, MacBride Promoted

FRANK C. BALFOUR, chief right of way agent for the California Division of Highways, retired February 1 after 30 years of state service.

Rudolf Hess, Assistant Chief Right of Way Agent (Northern California) since September, 1956, has been promoted to succeed Balfour.

The Division also announced the promotion of Dexter D. MacBride, Supervising Right of Way Agent and Balfour's administrative assistant since 1956, to Assistant Chief Right of Way Agent, replacing Hess.

Since 1943, Balfour has headed the Division's right of way department, one of the largest right of way aquisition agencies in the world.

He is recognized nationally as an authority on highway right of way matters and land economics. In the past 18 years he has been responsible for the acquisition of California real estate valued at about one billion dollars.

In 1943 the Division's annual expenditure for rights of way was about $5,000,000. Today, the annual right of way budget is approximately $150,000,000. The right of way department also acquires property for the State Public Works Board and the Department of Water Resources.



FRANK C. BALFOUR

Under Balfour's direction, California's highway right of way organization has come to be recognized as one of the outstanding of its kind in the country.

It was the first to publish a comprehensive manual setting forth acquisition procedures and the first to initiate an extensive program of in-service training.

As chief right of way agent, Balfour was instrumental in the establishment of the Division of Highways policy which assures the payment of fair market value for property required for highway purposes.

This policy eliminated "horse-trading" from right of way negotiations and insured payments equitable to both the individual property owner and the taxpaying public.

Balfour has constantly emphasized recruitment and development through civil service of trained and experienced right of way personnel

The success of these measures is demonstrated by figures on land acquisition for the 1959-60 fiscal year. Of the 7,052 transactions involving purchase of land parcels, about 98 per cent were negotiated settlements with property owners. Only two per cent were concluded through court proceedings.

Another widely endorsed feature of California's right of way acquisition program, established while Balfour headed the department, is the revolving fund for the advance purchase of rights of way.

The 1952 Legislature authorized this fund for the early purchase of property on which costly improvements are planned. Money paid out of the fund is later returned at the time when right of acquisition would normally be undertaken.

In the eight years since the fund was established, savings of more than $200,000,000 have resulted.

Pioneered under Balfour's direction were studies on the economic effect of freeways on communities. These studies have been used as guides in California and throughout the country.

Balfour is the founder and presently executive vice chairman of the American Right of Way Association. After

. . . Continued on page 79



RUDOLF HESS



DEXTER D. MacBRIDE

C.T.B.*

Improved Spreading Devices, Control Methods Speed Work

By L. D. WANEE, Assistant Construction Engineer

The use of cement treated bases (CTB) in the construction of highways in California became an accepted practice for certain traffic and economic conditions in 1938. Initially, plant mixing was specified to assure accurate control of the ingredient proportions and some of the results were excellent. One of these early highway projects utilizing aggregate similar to that used in concrete remained in excellent condition for more than 15 years, carrying traffic loads far beyond those originally estimated.

Classes of Bases

California currently uses four classes of cement treated bases. These are listed, with their principal characteristics, in the accompanying tabulation:

Note: See "Review of Cement Treated Bases in California" by Carl Alzueta, published in the May-June 1955 issue of *California Highways and Public Works*.

Mixing Methods

Over the years the development of efficient road-mixing methods which materially reduced costs led to specifications which permitted the contractor to use either plant-mix or road-mix methods. For economic reasons, almost all cement treated bases have since been road mixed, and results were, until recently, considered satisfactory except in a few cases.

With such wide application of road-mixing methods, various kinds of road mixers in use for road-mixed bituminous surfacing were adapted and developed for cement treatment, some of which mixed the cement and water with the aggregate which had been spread to grade and cross section on the roadbed. However, this latter type of mixer was not always op-



Sizing windrow of mineral aggregate for road-mixed cement-treated base operation. California requires that the quantity of material in windrows shall not vary more than 5 percent from that specified.



A cement spreader truck. This type of equipment can easily deposit cement within the tolerance allowed by California's 1960 Standard Specifications. (Above photos by Pettibone Wood Mfg. Co.)

* Cement-Treated Base.

QUALITY OF AGGREGATE

CTB class	Amount of cement	Size	Sand equivalent	When mixed with specified amount of cement, compressive strength required: Cement	7-day compressive strength	Resistance value
A	3.5 to 6%	¾" max. or as specified	25 min.	5% max.	750 psi	not specified
B	2.5 to 4.5%	¾" max. or as specified	not specified	4% max.	400 psi	not specified
C	2 to 3%	¾" max. or as specified	not specified	2.5% max.	not specified	80 min.*
D	specified for each project	Aggregate for Class D consists of material already in place on the roadbed.				

* Aggregate for Class C CTB must have an R-value of not less than 65 before mixing with cement.

* Cement treated base.

erated properly to obtain the full thickness specified, nor did it always disperse and mix the cement uniformly throughout the treated base both to the full depth specified and laterally. This deficiency was indicated by a wide variation in the strength of compressive test samples taken from various locations on the roadbed and pointed out the need for a quick way to field test cement distribution immediately after mixing.

Recognizing this need, the Materials and Research Department investigated and developed an "Acid-Base Titration Method" for determining the cement content in a sample. (See "Cement Test" in the November-December, 1959, issue of *California Highways and Public Works*.) This test has proved satisfactory and has emphasized the need for better control of cement distribution in road-mix methods, and more thorough mixing in some cases which involved certain mixing machines.

As a further result of tests and measurements of thicknesses of constructed bases, it was evident that the better control possibilities offered by plant-mix methods warranted the specifying of plant mix for certain main-line highways designed with cement treated base. Today about 10 percent of our bases are constructed using plant-mix methods.



The road-mixed cement-treated base operation uses a pugmill-type mixer and operates between sideforms set for concrete pavement 12 feet wide. (Photo by Pettibone Wood Mfg. Co.)

Specification Changes

The 1954 Standard Specifications were not specific as to tolerances relating to variation in cement content, uniformity of the mixture and thickness of the completed base. The 1960 Standard Specifications require that the cement content in the completed mixture shall not vary more than 0.4 of a percentage point from that specified by the engineer in the case of plant-mixed bases. This tolerance is increased to 0.6 of a percentage point for road-mixed bases. These tolerances were selected as being the acceptable limits after studying that which could economically be obtained using the best of the present mixing methods. At the same time, the need for better control in spreading or introducing the cement into road-mixed CTB was recognized as a major factor in control and some progress has been made in improving spreading devices.

The 1960 Specifications for plant-mixed cement treated base are more complete than the 1954 Specifications, particularly for continuous-mix plants. The requirements are now the same for continuous-mix asphalt concrete plants and cement treated base plants except for a few details. Provision for checking rate of aggregate and cement feed without interruption of plant operation, except momentarily, is now required.

Aggregate Supply

As California's highway program expands, economical sources of good mineral aggregates for highway construction continue to diminish. Since cement treatment can be used to make many otherwise unacceptable aggregates satisfactory for bases, it seems certain that cement treatment will become even more important as times

goes on. Expanded use of fine aggregates for treated bases may also result. Although some difficulty, due to low shear strength, has been encountered in the use of aggregates such as sand or silty sand used for Class C cement treated bases, the problem appears to be largely related to the surface texture of the base. Finishing such a base by the usual methods results in a smooth surface texture which, in some cases, allows the bituminous surfacing to slip under traffic loads, particularly where motor vehicles must slow down or stop. Preferred practice is to add the maximum amount of cement specified for Class C and roughen the surface when finishing the base.

Equipment in Use

The most popular type of mixer used in road-mixing cement treated base is a continuous-mix pugmill, partly enclosed in a cylindrical shell, which takes the material from a windrow, elevates it only over the bottom pan of the mixing chamber, introduces the water and mixes the ingredients as the machine advances. The material is deposited in a windrow then flattened with a spreader at the rear of the machine.

Another type of road mixer commonly used is a continuous-mix pugmill mixer which lifts the windrowed material completely off the subgrade to an elevated mixing box, adds water and cement, mixes the materials and deposits the mixture in a windrow behind the machine.

Three types of mixers used in the past, which mixed the cement with aggregate which had been spread on the roadbed to the required grade and thickness, although of large capacity, appear to require major modification before they can be made to produce a cement treated base which will meet the requirements of the 1960 Specifications.

Cement spreaders, used widely in past years for depositing cement on the windrows preparatory to road-mixing, have generally been unable to spread uniformly due to operation under a variable head of cement as the vehicle is emptied. This difficulty has been largely overcome by improved equipment which spreads the cement from a feed hopper through which cement is constantly recirculated so as to maintain a constant head above the spreading augers. Cement spreaders using this principle are capable of easily spreading within the 5 percent tolerance allowed by the 1960 Specifications.

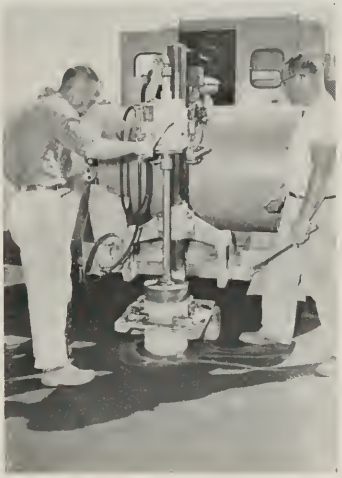
Spreading requirements for bases after mixing are much more specific than formerly, with methods in general specified and tolerances given. All classes of cement treated bases must be placed and completed within two hours after mixing.

Plant-mixed bases must be spread with self-propelled spreading devices that spread a lane width to the desired thickness ready for compaction. The use of motor graders, except for final trimming, is not permitted. The finished base must be within 0.05 feet of the required thickness.

Road-mixed bases may be spread with any device which will place the material to the required width and thickness. A variation of not more than 0.05 foot from the specified thickness is also required for road-mixed bases.

CTB Under Concrete Pavement

California uses cement treated base 0.33 foot thick under all portland cement concrete pavements, primarily to prevent pumping and development of "rocking" slabs. This base was formerly termed "cement treated subgrade."



Apparatus used for obtaining cores of completed pavement and bases to measure thickness and test the quality of materials.

Recent developments in concrete paving methods, such as paving 24 feet wide in one operation in lieu of 12 feet, and the use of the slip-form method which eliminates the necessity for setting side forms, have caused further changes in the underlying cement treated base operations.

One contractor, in changing over to 24-foot width formed paving, constructed a composite side form 20 feet long and 12 inches in depth by bolting two 10-foot metal side forms on top of a 4″ x 12″ x 20′ plank. His purposes were to assure more rigid side forms and to speed up form-setting operations. Then, instead of road-mixing, the CTB was plant-mixed in a continuous-mix central plant and spread with an asphalt paving machine. The cut to final grade was made by a subgrader riding on the side forms.

In the case of slip-form paving, the need for finishing the road-mixed CTB to the close tolerances required to assure that the completed pavement is satisfactory as to grade and cross section has created a problem. In this method of paving there are no side forms from which a machine can be operated to accurately cut the CTB to final grade and from which the subgrade can be tested for accuracy. Motor graders equipped with automatic blade control, a road grader using a variation of the land plane principle, and a self-propelled subgrading machine which is controlled at each side from taut piano wire guides, are being used with moderate success. The adaption of the long wheel-base subgrader which can operate off a taut piano wire set to grade appears also to be a possible solution.

Field Control

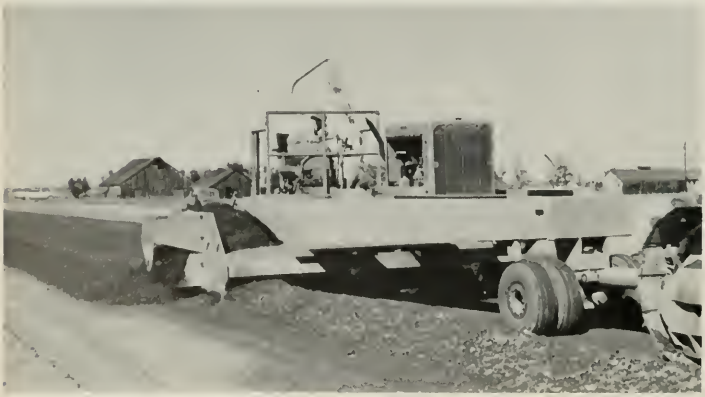
To assure uniform quantity, untreated aggregate for Classes A, B and C road-mixed cement treated base must be deposited upon the roadbed through a spreader box which will deposit the material within 5 percent of the rate required to provide the specified width and thickness. Windrows are spot-checked as necessary to assure that the tolerance is complied with. It is not adequate to check the material



Front view of the custom-built, cement-treated base road mixer. This machine picks up a windrow of material containing approximately 12 cubic feet per foot (loose) and mixes it in a continuous-type pugmill mixer.



A rear view of the custom-built, cement-treated base mixer shown above.



A land-plane type grader finishes the cement-treated base in advance of slip-form concrete paving operations.

per 100 feet of windrow. Much smaller increments must be used.

Cement must be spread in such a manner that the rate will not vary more than 10 percent from that designated. As with checking the quantity of aggregate in the windrow, the cement spread must be checked in small increments at various locations to assure that the spread is uniform as well as correct in amount.

If the aggregate and cement are deposited on the roadbed within the tolerances specified, and road-mixing is complete and uniform, it is not difficult to conform to the 0.6 percentage point requirement when the completed mixture is tested for cement content. For example, if 3.0 percent cement is specified, the acid-base titration test (Test Method No. Calif. 338) must show variations in the cement content within a range of 2.4 percent to 3.6 percent to be acceptable. This is a 20 percent variation, which may seem large, but prior to the use of the 1960 Specifications, variations of more than this were found in some cases. Subsequent study determined that the 0.6 point tolerance is practical and will assure acceptable bases.

In the past, variations in thicknesses of bases beyond that contemplated in design were found on some projects. This led to the tolerance of 0.05 foot now allowed by the 1960 Specifications. Frequent measurements of the compacted material through holes dug to the bottom of the base are necessary to assure compliance.

All cement treated bases must be completed through final compaction after trimming within two hours after the water has been added to the aggregate and cement in the mixing operations.

In the case of plant-mixed cement treated base, control of the correct proportioning of the aggregate, cement and water, is, of course, maintained at the plant. The variation in cement content is 0.4 of a percentage point instead of the 0.6 allowed in road-mix because a better product is desired and such accuracy is practicable to attain through proper plant operations.

The thickness of the uncompacted base, as well as the thickness of the

compacted base, is frequently checked by direct measurement in holes dug through the base. Since the base must be spread with a self-propelled spreading device, in most materials, once the ratio of compacted to uncompacted thickness has been determined, the compacted thickness may be predicated fairly accurately from measurement of the loose thickness.

Cement treated bases after 22 years of extensive use continue to serve well and no economical substitute has been found to replace this type of construction under the conditions used in California. The nearest substitute is the new Class 1 Aggregate Base described in the 1960 Standard Specifications. This is a well-graded, high-quality aggregate containing 80 percent to 90 percent crushed material. So far there has been only limited use made of Class 1, but in certain localities it may be used economically and may become a limited substitute for Class A cement treated base.



Placing plant-mixed cement-treated base using paving machines. With this method the thickness tolerance of .05 feet can easily be met and it reduces to a minimum the amount of finishing equipment required.

A table showing unit bids on representative projects is presented to illustrate present price ranges on typical projects.

REPRESENTATIVE UNIT BIDS ON RECENT PROJECTS

Approximate location nearest city or town	County	Cement Treated Base: Thickness (feet)	Mix method	Quantity sq. yds.	Unit price	Cement bbls.	Unit price	Pavement type and thickness (feet)	Class of CTB
1954 SPECIFICATION PROJECTS									
1. Dunsmuir	Siskiyou	0.33	Road	85,000	$0.22	2,930	$6.00	0.57 PCC	CTS
2. Castella	Siskiyou	0.67	Plant	95,000	0.25	5,500	5.00	0.33 PMS	B
3. Davis	Yolo	0.33	Road	128,000	0.25	7,700	4.00	0.57 PCC	CTS
4. Vallejo	Solano	0.67	Plant	114,250	0.40	8,470	4.50	0.33 PMS & 0.05 OG-PMS	B
5. Monterey	Monterey	0.50	Plant	33,000	0.40	1,855	4.30	0.25 PMS & 0.06 OG-PMS	B
1960 SPECIFICATION PROJECTS									
6. McKittrick	Kern	0.50	Road	35,300	0.11	2,400	5.40	0.25 AC	D
				Aggregate tons					
7. Los Angeles	Los Angeles	0.33	Road	47,400	2.40	2,100	3.90	0.57 PCC	B
8. Sunnyvale	Santa Clara	0.67	Road	12,000	2.85	3,350	4.00	0.25 AC	A & B
9. Lodi	San Joaquin	0.83	Plant	11,000	4.00	5,900	4.70	0.33 AC & 0.05 OG-AC	A
10. Van Nuys	Los Angeles	0.67	Plant	43,700	3.50			0.33 AC	B
		0.33	Road	31,900	3.15	115,300	4.00	0.75 PCC	A
		0.33	Road	31,700	3.15			0.67 PCC	B
11. Beaumont	Riverside	0.33	Road	32,800	2.20	92,000	3.40	0.75 PCC	A
		0.33	Road	37,100	1.80			0.67 PCC	B
12. Creston	San Luis Obispo	0.50	Road	15,900	1.25	1,800	5.00	0.25 AC	C
13. Fortuna	Humboldt	0.67	Plant	62,500	3.00	14,000	5.00	0.30 AC & 0.05 OG-AC	A & B

Abbreviations:
PCC—Portland cement concrete.
PMS—Plant-mixed surfacing (now termed asphalt concrete).
CTB—Cement treated base.
CTS—Cement treated subbase.
OG-PMS—Open graded PMS.
AC—Asphalt concrete.
OG-AC—Open graded AC.

Two F.A.S. Jobs

San Bernardino County Adds 4 Important Miles

By MARTIN A. NICHOLAS, County Engineer

WHILE general public attention has been focused upon the State's freeway construction program in the San Bernardino-Riverside area, the counties have been busily engaged in planning and constructing major arterials which complement the freeway system.

San Bernardino County has recently completed two major Federal-aid Secondary projects providing additional important traffic service in the San Bernardino valley. One of these projects consisted of widening 2¼ miles of Riverside Avenue (FAS 707) south of the City of Rialto and the other was the widening of Barton Road and Washington Street (FAS 714) for a total length of 1¾ miles between the Riverside Freeway and Waterman Avenue.

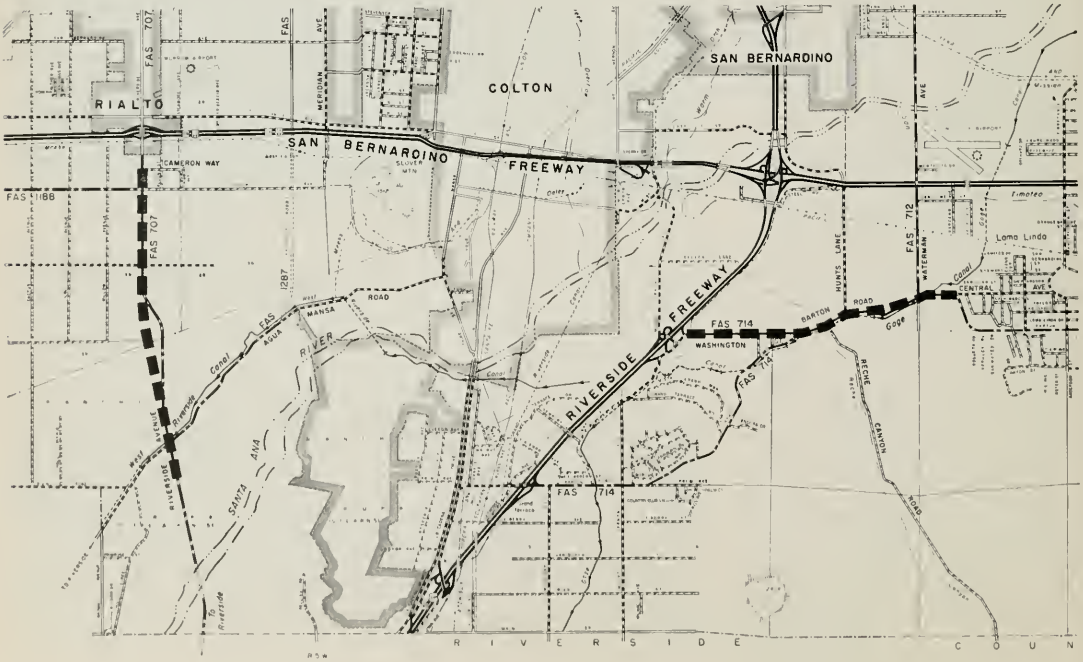
The following discussion of the planning and construction highlights on these projects illustrates the comprehensive planning and engineering work performed by the County in carrying on the Federal-aid Secondary Program.

Riverside Avenue

Studies of Riverside Avenue were begun in 1957 because of the low sufficiency rating reflecting approaching inadequate traffic capacity, the construction of an interchange with the San Bernardino Freeway, and general interest developing in the establishment of heavy service industries south of the City of Rialto.

The opening of the Riverside Avenue interchange involved the closing of the Meridian Avenue intersection at grade with the San Bernardino Freeway. Since Meridian had served as the principal access to the freeway for the California Portland Cement Company rigs, the closing was certain to create additional traffic on Riverside Avenue.

In estimating future traffic volumes, it was found that trend traffic (the normal growth on a particular route) and development traffic (the increase which would be generated by vicinity development) would create a demand of 21,000 vehicles per day by 1979, with an unusually high percentage of these vehicles being trucks. As esti-



The two projects discussed in this article are shown in the above map by the heavy dash lines.

mated in 1957, Riverside Avenue (then carrying 4,000 vehicles per day) would become critically deficient within the next five years.

Riverside Avenue functions as a prime local through arterial between the Cities of Riverside and Rialto, which areas are expanding rapidly. It is the principal north-south street in the City of Rialto extending northerly to connect to the Devore Cutoff and serves as an important link southerly to the central business district of the City of Riverside. It also has advantageous connections to the three east-west State highways on the north, the San Bernardino Freeway, Foothill Boulevard and Highland Avenue.

Phase Construction Planned

Study of such factors as traffic, costs, financing, and Riverside City and County advance planning problems led to the decision that the route improvement should be planned as phase construction. It was evident that reconstruction from Cameron Way south to Agua Mansa Road would logically be the first phase. Here, the greatest immediate need was indicated by higher traffic densities and expanding industry.

The second phase, from Agua Mansa Road south to the Riverside County Line, will require bridging the Santa Ana River, for which the precise alignment of the channel has not been fixed. It was apparent that second-phase improvement would not be necessary or possible until sometime in the future.

Cost consideration was the factor which influenced the decision to design and construct a four-lane highway with only a four-foot painted median. Acquisition of additional right of way for a fully divided facility would have increased the cost beyond the funds available.

Reversing curves north of Agua Mansa Road were eliminated and replaced by a 6,000-foot radius curve on new alignment.

The entrance to the Service Rock Company, which angled into the intersection of Riverside Avenue and Agua Mansa Road on the northwest quadrant forming a five-way intersection, was relocated westerly to connect directly to Agua Mansa.



The Riverside Avenue F.A.S. project looking from above the San Bernardino Freeway south toward Riverside.



The Washington Street-Barton Road project constructed by San Bernardino County under the F.A.S. Highway Program. The view is northeastward with the Riverside Freeway interchange in the foreground.

The West Riverside Canal Crossing under Riverside Avenue, paralleling Agua Mansa Road on the north side, was bridged with reinforced concrete slabs supported by concrete walls.

Barton Road—Washington Street

Simultaneously with the studies of Riverside Avenue the county planners were considering Barton Road and its Washington Street connection to the new Riverside Freeway.

Barton Road, although improved in 1949 under an F.A.S. project to a high standard two-lane highway, was carrying 9,000 vehicles per day in 1957, maximum capacity for such a facility. The route is expected to be carrying approximately 12,000 vehicles in 1961 and 21,000 vehicles in 1981. The 1981 volumes can be compared to the existing traffic on US 99 between the Riverside Freeway and the City of Redlands.

The Washington Street-Barton Road Highway lies in a strategic location immediately south of the City of San Bernardino and east of Colton, an area having an almost assurred potential for a transition from agriculture to residential, commercial and industrial development. Functionally, it is a multipurpose arterial highway carrying traffic between the cities and communities of Riverside, Highgrove, Grand Terrace, Colton, San Bernardino, Loma Linda, Bryn Mawr and Redland. It provides convenient connections to the Riverside Freeway and the San Bernardino Freeway, and access to the important north-south principal streets which lead to the business and commercial districts of Colton and San Bernardino as well as a major employment center, Norton Air Force Base.

High Right-of-way Cost

Although the 20-year traffic projection indicated that it would be desirable to construct a four-lane physically divided highway the entire length of the project, an analysis of the expense involved in acquiring additional right of way and moving the many homes along Washington Street revealed that the cost would be prohibitive. Consequently, a four-lane curbed highway with a four-foot painted median was selected as a compromise for Washington Street. For



The eastern end of the Barton Road F.A.S. project in San Bernardino County. Waterman Avenue intersection is in the center.

Barton Road between Washington Street and Waterman Avenue where right of way was reasonable in cost and could be easily acquired, a fully divided four-lane highway was designed and constructed. It is of importance that this portion of the project can be widened to six lanes by reducing the 46-foot median to 22 feet when the additional capacity is required in the future.

In the treatment of the final portion of the route from Waterman Avenue to Central Avenue, there is a difference in elevation of the eastbound and westbound roadways designed to preserve access to abutting properties.

To provide a smooth flowing free right turn from westbound on Barton Road to northbound on Waterman Avenue, it was necessary to acquire considerable right of way, including a residence and outbuildings and to bridge a portion of the Gage Canal Company main waterway for a distance of approximately 300 feet.

Crosses a Canal

The canal crossing diagonally under Barton Road at Waterman Avenue presented a problem. A reinforced concrete cover was designed for the canal, supported by piling. An unusual construction feature of this installation was the use of concrete piling cast in place. Since the canal was concrete-lined and covered with only a lightly reinforced concrete arch, this type of piling was chosen because it could be placed without the damaging vibration which usually accompanies driven piling. It was incumbent on the County to perform the work without rupturing the canal lining or interrupting service.

High standard channelized intersections were built on Barton Road at Washington Street, Reche Canyon, Hunts Lane and Waterman Avenue to minimize the hazard of high-volume conflicting movements. The islands were curbed and paved inside to provide better visibility and less maintenance.

Traffic signals and safety lighting were installed at the major intersection of Barton Road and Waterman Avenue. Three-phase traffic-actuated signals were specified to handle the unbalanced movements assuring minimum delay and maximum efficiency. Safety luminaires of the 20,000 lumen class furnish adequate night-time visibility of all vehicles within the intersection proper. San Bernardino County accomplished the widening of these four miles of important county roads at a total construction cost of approximately $500,000. This included $301,583 of Federal-aid Secondary funds and $67,188 of State Highway Matching Funds.

ADEQUATE DESIGN STRESSED

Proper design of acceleration and deceleration lanes can practically eliminate accidents at freeway interchanges, according to a report presented at the 40th Annual Meeting of the Highway Research Board in Washington, D.C., by R. L. Fisher of the New Jersey Highway Department.

Arroyo Seco

Pasadena Freeway, First In West, Has 20th Birthday

By A. D. GRIFFIN, Supervising Highway Engineer (Retired)

THE PASADENA Freeway from the four-level structure at the intersection with the Hollywood Freeway near the Los Angeles Civic Center area northerly to Glenarm Street in the City of Pasadena is 8.2 miles in length, with total cost to date for right-of-way and construction shown by the record to be $12,218,000. This important freeway logically divides into two units at Avenue 22.

The construction for six miles northerly from Avenue 22 to Glenarm Street in Pasadena is old design and was completed at a cost of $6,000,000 prior to December 30, 1940. This section was known as the "Arroyo Seco Parkway," costing $1,000,000 per mile. The southerly portion, being 2.2 miles in length from Avenue 22 to the four-level structure, is, in every sense of the word, a modern design freeway for which construction was carried out after December 30, 1940. Its cost per mile was $3,000,000. The record shows that the last unit of the southerly section to connect the Pasadena Freeway with the four-level structure was not completed and opened to public traffic until December 22, 1953. P. O. Harding, who was Assistant State Highway Engineer in charge of District VII from 1949 to 1956, always referred to this key construction project as "pulling the plug."

Old Section Described

Thus, we have on the Pasadena Freeway two sections—northerly the old $1,000,000 per mile freeway and southerly the new $3,000,000 per mile freeway. The subject of the present story is the six-mile older northerly section now 20 years of age, and for clarity this writeup throughout refers to it by the original name "Arroyo Seco Parkway."

On December 30, 1940, when the six-mile length of the Arroyo Seco Parkway was dedicated and opened to public traffic, it was acclaimed by civic leaders and motorists as "the West's first freeway." It extended from Avenue 22 in the City of Los Angeles through Arroyo Seco park lands and private property into the City of South Pasadena adjoining Grevelia Street, entering the City of Pasadena at Garfield Street and ending where Glenarm Street intersected Broadway.

A. D. Griffin retired as Assistant District Engineer and Executive Assistant to Assistant State Highway Engineer Edward T. Telford in District VII on August 1, 1960. He had completed 41½ years of service with the Division of Highways. He had been a resident engineer on early roadbuilding projects, design engineer in charge of the district's plan preparation program for highway and freeway construction, 1927-1947, and Assistant District Engineer-Administration, 1947-1960. As design engineer, he had direct charge of plans for the development of the Arroyo Seco Parkway-Pasadena Freeway. He is therefore the logical authority to write this commemorative report on the 20th anniversary of the construction of the Pasadena Freeway.

The occasion for this story is the 20th anniversary of its opening. There should be such a story because during the 20 years that have elapsed since this freeway was opened to public traffic, while there have been occasional stories in the press and in technical magazines, almost nothing has appeared relative to the Arroyo Seco Parkway in *California Highways and Public Works*. Such references that have been made to it have been in connection with stories about other freeways. Everybody has been so engrossed in the newer freeway projects that there was no time for going back into the old.

1941 Writeup

Perhaps another reason for the dearth of writeups was that it was so well covered in the January 1941 issue of this magazine and also in the special pamphlet prepared for distribution at the dedication ceremonies on December 30, 1940.

Still another reason could be that there has been very little new construction or reconstruction carried out on this freeway during the 20-year interval. The expenditure of construction funds during the 20 years has been comparatively small, being largely for additional safety lighting and signing, reconstruction of landscaping, installation of chain link fence in the central median and for refuge areas.

During the years 1949 and 1950, at a cost of about $1,000 apiece, 50 "refuge areas" or "safety bays" were installed on the Arroyo Seco Parkway. As traffic volumes increased, these were found to be necessary because there were no shoulders for emergency parking on this freeway.

The original design of the Arroyo Seco Parkway called for a four-lane freeway with shoulders on both sides. Recognition of traffic considerably in excess of that originally expected caused a last minue change in the design, wiping out the earth shoulders and substituting in their place another lane of pavement, thus providing a six-lane freeway. Because of constricted right-of-way, where for long lengths the freeway was located between the Arroyo Seco channel on the one side and Union Pacific Railroad on the other, it was impractical to obtain shoulders in addition to the six-lane freeway. When vehicles broke down or motorists needed to change a tire, this had to be done out on the pavement lanes. Thus, the installation of the refuge areas, at strategic locations where the topographic conditions would permit, fulfilled a vital need.

The first survey for a highway in the Arroyo Seco was made in 1895 by T. D. Allen of Pasadena. Then early in the 1900's a bicycle speedway, sponsored by a Horace Dobbins, was partly constructed but never fully completed. As the Arroyo Seco began to be developed as a city park, a few more or less disconnected unimproved park roads were built. In the early 1930's, as traffic on existing city streets between Los Angeles and Pasadena began to approach congestion, the need for a new traffic artery in the Arroyo Seco area began to gain public recognition. In 1934 a committee, consisting of Edward S. Graham, chairman, and J. C. W. Hinshaw, Harrison Baker, Harold B. Bryon, J. K. Dotten, Robert Swink and William Wilson, was appointed by the Pasadena Realty Board to look into the possibility of road development in the Arroyo Seco.

Association Is Formed

Later the Arroyo Seco Parkway Association was formed to work in conjunction with the Pasadena Chamber of Commerce. Its officers included Graham, chairman, Hinshaw, Baker, William Dunkerley, Major Charles T. Leeds, F. G. Martin, R. W. Caspers and Jackson Kendall. This association was very active in publicizing the need for a new traffic artery in the Arroyo Seco and obtaining the co-operation and support of city officials of Pasadena, South Pasadena and Los Angeles and the various civic organizations interested in highway development.

Shift of Scene

"The scene now shifts to Sacramento for the final and most important step—the securing of an act of the Legislature making the Arroyo Seco Parkway a state highway. The Arroyo Seco Parkway Association assigned a special committee, and for their yeomen's work, J. C. W. Hinshaw, now congressman, Edward S. Graham, Harrison R. Baker and William Dunkerley gained the title, 'The Four Horsemen of the Arroyo Seco.' With the approval and co-operation of the administration and through the splendid services of Miss Eleanor Miller, representing the 47th Assembly District, who introduced the bill and saw it through final passage, the vision neared reality.

"The snowball had been started and the individuals retired from the front line trenches leaving the project in the care of the California Highway Commission and such able men as State Highway Engineer Charles H. Purcell, District Engineer Spencer V. Cortelyou and Frank C. Balfour, supervising right-of-way agent of the State Division of Highways."

"Arroyo Seco" is Spanish for "dry wash" and it is that for more than 99 percent of the time. However, during times of winter storm, heavy rainfalls can cause serious flooding conditions when storm waters in the Arroyo Seco natural channel, as it existed years ago, overflowed its banks. No serious thought could be given to the establishment and engineering design of a highway arterial in the Arroyo Seco until the flood control problem had been solved. In commenting upon this situation in the August 1940 issue of *California Highways and Public Works*, Cortelyou stated as follows:

"Special mention should be made of the very effective efforts of City Engineer Lloyd Aldrich of Los Angeles in securing for the people of Los Angeles City, after numerous trips to Washington, D.C., the allotment of large amounts of federal relief funds for important engineering projects in Los Angeles City.

Channel Financed

"One of the most important of these was the financing of the paved channel for the Arroyo Seco flood waters from South Pasadena to the Los Angeles River. Without this control of the flood waters, it would not have been possible to build and maintain the Arroyo Seco Parkway in its present location.

"The total cost of the Arroyo Seco channel work, carried out as a Federal Relief Labor project, was about $7,000,000."

When the Arroyo Seco Parkway was under engineering design as a freeway, there was little in the way of established precedent that could be followed. It is true that there were two such highways that had been built in the east but these had not been in operation long enough to determine the practicability of certain features of their design. Thus, to a very considerable extent, the design features of the Arroyo Seco Parkway had to be worked out independently. Original sketches contemplated the kind of a curving low standard highway that would be suitable for slow-speed sight-seeing traffic through a city park.

In the early days officials of the Cities of Los Angeles, Pasadena and South Pasadena were unanimous in the view that, since the Arroyo Seco Parkway was for the most part through city park lands, heavy trucking should be prohibited. In designing the on- and off-ramp connections for this freeway, the engineers of the Cities and of the State took this into account and made considerable money saving by establishing curvature suitable for passenger vehicle operation but not for big trucks. All three of these cities have passed ordinances prohibiting trucks weighing more than 6,000 lbs. from using the Arroyo Seco Parkway. It is interesting to note that this prohibition of heavy trucks was by city action in accordance with established laws, establishing alternate routes on existing city streets and was not action on the part of the State Division of Highways.

Improved Design

The design finally approved and constructed was vastly improved over the original. Much credit is due to City Engineer Aldrich and his Deputies, Merrill Butler, L. E. Arnold, C. J. Shults, L. W. Armstrong and R. W. Stewart, in preparation of plans for the Arroyo Seco Parkway with its large number of bridge structures. The same may be said for City Engineer Harvey W. Hincks of Pasadena and his assistants for the plans they made of the portion of the parkway in Pasadena and South Pasadena. The final design work by the city engineering staffs was carried out in close co-operation with the engineers of the State Division of Highways to the end that specifications could be written complying with state standards and that state construction contracts could be advertised and let.

Among the contractors that were engaged in major construction operations on the Arroyo Seco Parkway prior to December 30, 1940 are the following: The Contracting Engineering Company, J. E. Haddock, Ltd., Columbia Steel Company, Claude Fisher Co., Ltd., V. C. K. Construction Company, Oscar Oberg, J. S. Metzger & Son, Carlo Bongiovanni. The money to finance construction came from sources as follows:

State 1½ cent gas tax fund	$2,614,547.72
¼ cent state highway gas tax for Pasadena	335,981.98
¼ cent state highway gas tax for South Pasadena	64,778.36
¼ cent streets of major importance gas tax for South Pasadena	12,271.04
¼ cent state highway gas tax for Los Angeles	40,000.00
South Pasadena city funds	644.16
Los Angeles city funds	113,584.14
P.W.A. funds	472,315.63
W.P.A. funds	1,394,364.73
Total	$5,048,487.46

On December 28, 1940, just two days before the official ribbon-cutting ceremony for the Arroyo Seco Parkway, a symbolical and highly colorful ceremony was staged in the Arroyo Seco. Chief Tahachwee of the Kawie Indians, whose ancestors lived in the Arroyo wilderness for hundreds of years before the coming of Father Junipero Serra and his Franciscan mission builders, smoked the pipe of peace with Director of Public Works Frank W. Clark. To the beating of tribal drums, Chief Tahachwee relinquished the rights of his people in the Arroyo Seco and formally transferred their ancient property interests to the State.

Governor Officiates

At the ribbon-cutting ceremony on December 30, 1940, Governor Culbert L. Olson officiated, and with the assistance of Miss Sally Stanton, Queen of the 1941 Pasadena Rose Festival, and other high dignitaries of federal, state, county and city governments and civic leaders, cut the ribbon of roses which stretched across the freeway near the Fair Oaks Avenue Bridge. On this occasion Governor Olson said:

"Forty-five years between the first survey and today's splendid comple-



BEFORE. In January, 1940, the Arroyo Seco looking north from Avenue 60 looked like this. The Santa Fe Railroad viaduct is in the background.



AFTER. Fifteen years later the above section of the Arroyo Seco looked like this.

tion. This is a long time. But perhaps it is just as well that the dream was a long time in its dreaming. Perhaps it is just as well that many obstacles stood in the path to its final realization. Perhaps it is just as well that the dream had to wait, and wait—wait until, under the pressure of sheer necessity it finally burst out of the confining walls of public indifference, official inertia, selfish opposition, and narrow vision. It is just as well because, while confined, the dream grew and matured. So, when that dream was translated into legislation, that legislation was well conceived and broad visioned. And when the engineers were finally told to go to work, their working plans were *bold* and comprehensive, and they have given us something worth while.

"I say *bold* because they were just that. They dealt boldly and realistically and *effectively* with a traffic problem that had become almost terrifying in its urgency of solution. Now that we have it, and it all looks so rather simple, so obviously necessary, so wholly practical, some there will be who will ask, 'What is there so wonderful, or so bold about it?' Oh, yes—but it takes courage to do a thing the *first* time, no matter how simple and obvious it may appear *after* it is done. And this, fellow citizens, is the *First Freeway in the West.*"

With the cutting of the ribbon, a cavalcade consisting of an estimated 400 automobiles made the round trip over the completed Arroyo Seco Parkway.

Economic Benefits Stressed

Officials and members of the Automobile Club of Southern California, particularly E. E. East, Chief Engineer, and Hal Holley, his assistant, in the old days were enthusiastic advocates of the Arroyo Seco. East contributed a story about the economic benefits to be expected from the Arroyo Seco Parkway in the pamphlet that was distributed at the dedication ceremonies on December 30, 1940. This pamphlet of 14 pages was prepared by Kenneth C. Adams longtime editor of *California Highways and Public Works*, who retired from state service in 1957. The pamphlet was printed by the Automobile Club of Southern California as a part of their participation in the dedication ceremonies. It contains much interesting information about the Arroyo Seco Parkway which is of historical value, and so few copies are in existence that a copy now has become a collector's item for those interested in Californiana.

In 1951 the Arroyo Seco Parkway scored another first in connection with the building of the first bridge in California using the prestressed-precast principle for building a concrete bridge. The occasion for this construction was an agreement made some 15 years previously between the Los Angeles City Park Department and the State Division of Highways to the effect that a pedestrian bridge would be built if and when development of park facilities required access to a certain area in the Arroyo Seco Park near the South Pasadena city limits where access to adjoining park lands was cut off by reason of freeway construction on one side and storm drain channel construction on the other. The agreement stated that when the City Park Department needed access to this area that the State would at that time construct a pedestrian bridge across the Arroyo Seco storm drain channel. Until that time only two bridges had been constructed elsewhere in the United States using the prestressed-precast principle.

Bridge Attracts Attention

During construction the bridge attracted considerable attention in the engineering field, and stories concerning it appeared in *Engineering News Record*, *Civil Engineering*, *American Concrete Institute Journal*, *Western Construction*, *California Highways and Public Works* and others. The story in this last-mentioned publication appeared in the March-April, 1951, issue under the title "Prestressed Bridge," authored by Robert M. Barton, associate bridge engineer.

The bridge consists essentially of two simply supported girders, each 113 feet long, with a clear span of 110 feet. These girders support the eight feet wide pedestrian walkway and also serve as handrails. The girders were constructed in an area alongside the channel and were lifted into place by three giant truck cranes after prestressing operations had been completed. The work was done under a state contract with Contractor Walter Kaucher of Los Angeles. The total cost including engineering was $31,-877. Jack Sylvester was resident engineer on the project for the bridge department.

In commenting upon the project, Dale F. Downing, who is now southern representative for the bridge department with offices in Los Angeles, states: "The value of this initial project in adapting prestressed concrete to bridge construction is best illustrated by the fact that prestressed concrete structures have been used to some extent on every freeway in the Los Angeles metropolitan area. The experience and lessons first learned here during design and construction has undoubtedly led to greater economy and more efficient bridge construction throughout the State."

Design Called "Bold"

When the Arroyo Seco Parkway was dedicated by Governor Olson on December 30, 1940, he stated that it was a "bold" design. In many respects it did seem so at the time, but because the many so-called "bold" features have since proved inadequate for present day high speed traffic, much has been learned by study of various features of design on the Arroyo Seco Freeway. In a sense, the Arroyo Seco Freeway has been an experimental laboratory although it was not built as such. Invariably when we have officials from other states or visitors from foreign lands who wish to inspect the Los Angeles Freeway System, they always ask to see the Arroyo Seco Parkway because they wish to compare the old with the new and see what lesson can be learned.

A. L. Himelhoch, District Engineer-Operations, summarizes the lessons to be learned from the old design standards as incorporated 20 years ago in the Arroyo Seco Parkway, as follows:

1. A four-foot median is too narrow to provide space for safety features or planting of shrubbery. Chain



BEFORE. This view of the Arroyo Seco, looking north from Hermon Avenue, was taken in 1933.



AFTER. The same portion of the Arroyo Seco (shown above) as it appeared in a recent photograph.

link fence that had been installed in this median has had to be removed due to repeated damage by vehicle collision. The planting of shrubbery in the median strip to screen out headlight glare has proved a complete failure in the four-foot-wide median strip because plantings could not survive the whipping action of passing vehicles. The action is similar to subjecting plant life to a continuous 60-mile-an-hour gale. In the six-foot-wide median strip where the freeway goes through South Pasadena and Pasadena, however, pyracantha shrubs have survived.

2. On the Arroyo Seco Parkway, acceleration and deceleration lanes are conspicuous by their absence. Vehicles entering the freeway are required to come to a stop at the approach to the freeway roadway. This is not in accordance with modern freeway design which from the standpoint of efficiency and safety provides sufficient acceleration and deceleration lanes so that traffic entering and leaving the freeway will not impede or be impeded by the freeway traffic.

3. On the Arroyo Seco Freeway the superelevation or banking of curves was done to only one-half of the present day standard. It is largely for this reason that this freeway has been signed for a speed of 55 miles per hour instead of the state speed limit of 65 miles per hour. The present day standard of superelevation is necessary for freeway operation at maximum efficiency.

Shoulder Width Important

4. This freeway, lacking shoulder width, demonstrates the need for shoulders on all freeways of adequate width to take care of vehicles that become disabled. On the Arroyo Seco Parkway, this has been partly remedied by the construction of refuge bays, but only partly so because vehicles can break down between the safety areas off the pavement as now provided.

5. The Arroyo Seco Parkway has a number of curves of 1,000-foot radius and one compound curve where the minimum radius is 555 feet. This latter sharp curvature occurs where the freeway alignment follows parallel to a sharp curve in the Arroyo Seco Channel as it passes under the Santa Fe Railroad viaduct. To have eliminated this sharp curve would have required an expenditure of a million dollars or more, and that additional money was just not available at the time this freeway was constructed. A speed zone around this sharp curve has been established at 40 miles per hour and at this reduced speed, traffic can negotiate it with safety. It is clearly demonstrated here that the minimum radius of curvature for modern freeways should be 2,000 feet.

6. The two roadways of the Arroyo Seco Parkway are 35 feet in width consisting of three 11-foot lanes with one-foot gutter widths adjacent to curbs. While this item is perhaps a not too glaring deficiency on this freeway which does not have to handle heavy trucks, it does clearly demonstrate the value of having 12-foot width of traffic lanes for modern freeways.

7. On this freeway both rounded and straight-sided barrier type roadway curbs were installed. Generally speaking, where curb delineation is required the evidence is that rounded curbs which traffic can easily negotiate for emergency parking are preferable for modern freeways.

Future Improvements

In describing future improvements that are planned for the Arroyo Seco Parkway section of the Pasadena Freeway, R. E. Deffebach, assistant District Engineer in charge of Design Section "A" in District VII, reports that the 1960-61 budget contains a $363,000 allocation for median barrier construction for the entire length of the Pasadena Freeway between the four-level structure in Los Angeles and Glenarm Street in Pasadena. This median barrier will provide a positive protection against vehicles crossing the median strip and becoming involved in head-on collisions with traffic moving in the opposite direction.

The type of barrier for the sections of median six feet or more in width will be the new standard double blocked-out type of barrier. Where the median is only four feet in width, as is the situation for the major length of the Arroyo Seco Parkway, then the "blocked-out" feature will have to be eliminated.

At the southerly end of the Arroyo Seco Parkway at the intersection with the new Golden State Freeway, an extensive traffic interchange facility is under construction under a con-



BEFORE. This pre-1940 view shows the Arroyo Seco looking north from South Pasadena City boundary.

tract with Vinnell Corporation, Vinnell Constructors and A. S. Vinnell Company, for which the total contract allotment applied between Pasadena Avenue and Arnold Street is $9,693,200. This construction is scheduled for completion, February, 1962.

For additional information concerning the Golden State Freeway, reference should be made to the "Freeway Loop" story by L. R. Gillis, *California Highways and Public Works*, September-October 1959 issue.

Studies Being Made

Deffebach also reports an item of great local interest applying near the south end of the Arroyo Seco Parkway. His design section has under preliminary study that section of the Pasadena Freeway in the vicinity of Elysian Park where the Los Angeles Dodgers baseball park is now under construction and where the proposed City of Los Angeles World Zoo and other recreational facilities will materially change the traffic pattern in this area. It is necessary that these studies be carried out now in co-operation with the city engineering staff of the City of Los Angeles, in order to determine the revisions that will be necessary in the existing freeway on- and off-ramps and in existing city street layouts.

16-HOUR TRAFFIC VOLUMES FROM ANNUAL COUNT BOOKS 1941-60 AT CYPRESS AVENUE PEDESTRIAN BRIDGE

Year	*Sunday*	*Monday*
1941	24,364	27,234
1942	19,494	22,561
1943	17,151	20,663
1944	17,750	21,488
1945	20,383	25,323
1946	31,427	43,805
1947	28,931	40,906
1948	28,451	41,659
1949	30,932	45,047
1950	30,967	49,225
1951	33,862	50,708
1952	34,799	51,101
1953	35,110	52,137
1954	40,343	59,551
1955	41,820	62,582
1956	47,467	64,749
1957	45,363	64,645
1958	45,206	66,499
1959	42,221	64,797
1960	44,688	68,766

Assistant District Engineer J. E. Eckhardt, in charge of the District VII Traffic Department, has prepared the accompanying tabulation showing 16-hour traffic volume counts on Sundays and Mondays during mid-July of each year between 1940 and 1960, and the chart shows a steady and consistent increase, except for the World War II years.

Apparently from 1955 through 1959, the actual counts would indicate that this freeway is working at full capacity under the existing conditions. During 1960, it is Eckhardt's opinion, due to steps which have been taken by large organizations to stagger office hours the peak hours for traffic on all freeways have been considerably lengthened. In some cases it would appear that the morning and night peak hours are no longer of one hour duration but are of two hours or even more. With the definite tendency for the traffic peaks to be of longer duration, it is possible for a greater number of vehicles to utilize the freeways than heretofore. Apparently the Arroyo Seco Parkway portion of the Pasadena Freeway is showing increased usage by motorists due to this fact.

No Special Studies Needed

Eckhardt further states that even though in many respects this freeway is substandard design by present day evaluation that the Arroyo Seco Parkway is, generally speaking, as safe as any of the other freeways. There are no points on the Arroyo Seco where accident concentrations would indicate the need for special studies and corrective measures. Thus, it appears that notwithstanding the fact that the Arroyo Seco Parkway is substandard, it still is giving the motorists of Southern California yeoman service.

The increase in traffic using the Arroyo Seco Parkway can well be understood when one considers the explosive population growth that has occurred in this area during the past 20 years, as indicated by the attached summary.

POPULATION

	City of Pasadena	*City of Los Angeles*	*County of Los Angeles*
1940	81,864	1,504,277	2,785,643
1950	104,577	1,970,358	4,151,687
1960	123,984	2,488,750	6,059,161

Future Outlook

It is the opinion of E. T. Telford, assistant state highway engineer now

. . . Continued on page 72



AFTER. The same area in the photograph on the previous page taken 15 years later.

Utility Problem

Cable Relocation Offers Challenge on Bridge Job

By L. E. MULLIN, Assistant Highway Engineer



AN EXISTING bridge over San Lorenzo Creek at the intersection of Mattox Road and East 14th Street near Hayward is being reconstructed and enlarged as a part of a 3.9 million dollar flood control project to increase the capacity of the San Lorenzo Creek Channel.

A Cooperative Agreement was entered into between the US Army Corps of Engineers, the Alameda County Flood Control and Water Conservation District, the County of Alameda and the State to jointly finance the reconstruction of this bridge with the main portion of the required funds contributed by the Alameda County Flood Control and Water Conservation District.

The highway traffic is approximately 30,000 cars per day and only half of the structure could be demolished and reconstructed at a time.

Telephone Ducts Described

Investigation revealed that the Pacific Telephone and Telegraph Company maintain a 12-way duct structure on one side and an 11-way duct structure on the other side of East 14th Street. These ducts contain nine full cables ranging in size between 455 and 909 pairs, and a coaxial cable which links Los Angeles and Oakland.



The completed bridge showing East 14th Street in background. Note the three telephone cables still suspended on the shaofly. The telephone company will require nine weeks to place and splice cables within the new bridge prior to removing the aerial cables.



ing the utilities to accommodate the new bridge will be approximately $60,000.00.

Dan Caputo Company submitted a low bid of $303,399.00 and the contract was awarded to them on August 26, 1959.

The manner in which these telephone facilities were rearranged has provided minimum interference to the contractor's operations and resulted in a minimum of cost to the Utility Company, the Contractor and the State, for what is probably one of the shortest highway construction projects involving major utility facilities.

A view of the pile driver in operation between the suspended telephone cables and the west half of the new bridge.

This coaxial cable contains eight coaxial tubes which can carry a maximum of 1,820 telephone conversations or two television programs and 620 telephone conversations simultaneously over each pair of tubes.

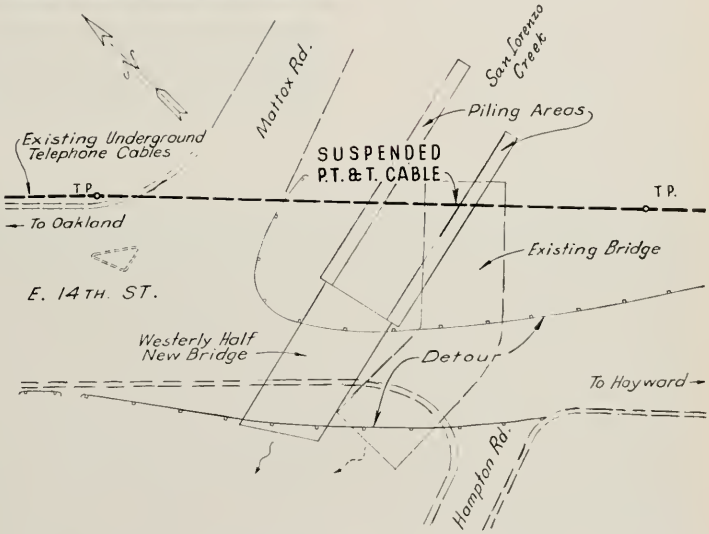
The existing bridge was constructed on a skew, and the alignment of the bridge and the position of the ducts governed the line where the first half of the bridge could be demolished.

The Telephone Company made studies and a plan was developed wherein the facilities on one side of the bridge could be placed on a shoofly. The Company had to construct two manholes and intercept the underground conduit and place three cables and the coaxial cable aerially on a shoofly to clear the contractor's pile driving operations.

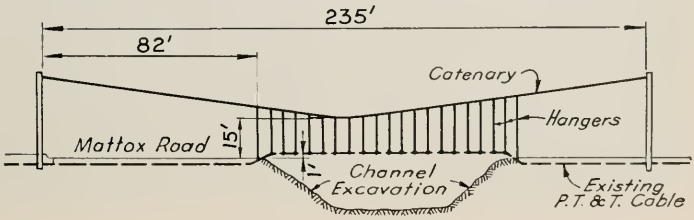
Cables Could Be Lifted

On the other side, the six telephone cables were close enough to the outer edge of the bridge so that the Company could place the cables in a sheet metal casing, lift them vertically and suspend them on a catenary as shown in the picture, while the contractor rebuilt the bridge. These cables still had to be shifted during construction a few feet laterally to clear the driving of individual piles.

The bridge has approximately a 100-foot span and the cost of relocat-



After the west half of the bridge was constructed, it was used as part of the detour and the six telephone cables on the east side of East 14th Street were raised and suspended by catenary construction prior to the driving of piles for the remaining section of the bridge. UPPER—a map of the construction area. LOWER—a profile of the area indicated by the dash line marked "Suspended P.T.&T. Cable."



Harding Way

Traffic Flow in Stockton Aided by New Underpass

By R. J. GREENBERG, Assistant City and County Projects Engineer



WHEN the Harding Way Underpass was dedicated and placed in full operation on August 25, 1960, approximately 15,000 vehicles per day began passing safely, and without interruption, under the Southern Pacific Company and Western Pacific Railroad Company mainline tracks. The completion of this modern four-lane underpass eliminated one of the most serious bottlenecks to the movement of vehicular traffic within and through the City of Stockton.

This $1,080,000 structure, which was designed by H. C. Holman of Stockton and constructed by Stolte, Inc., and Lee Stephens, was jointly financed by the City of Stockton, the State Division of Highways and the two railroad companies.

Crossing Eliminotion Considered

For several years, the City considered the elimination of these mainline railroad grade crossings on Harding Way of utmost importance, not only from a safety standpoint, but also as a savings in both time and operational costs to the vehicle owner and operator. However, not until the citizens of Stockton approved a Public Improvement Bond Issue, and until State funds became available through new legislation, could the structure become a reality.

The State Legislature, effective September 11, 1957, established an annual $5,000,000 Grade Separation Fund. The law providing this fund, as amended, provides that not more than $5,000,000 of the Highway Users Tax Fund be set aside annually to assist local governmental agencies, both City and County, in eliminating railroad grade crossings, and for improving existing railroad separation structures on city streets and county roads. Rail crossings on State highways continue to be a State responsibility.

Under this law, the State Public Utilities Commission is required to establish yearly and furnish to the State Department of Public Works a "priority list" of railroad grade crossings which, in the Commission's judgment, justifies elimination by construction of separation structures, or justifies alteration or reconstruction in the case



The new Harding Way Underpass in the City of Stockton, looking eastward.



Workmen place reinforcing steel in the south retaining wall of the Harding Way Underpass.



An aerial of the completed Harding Way Underpass (right center). At the center of the phata is the Stacktan State Hospital.

of existing structures. This law further provides that the railroad or railroads contribute no less than 10% of the cost, and that the balance be shared equally between the local governmental agency and the State.

Determination Priorities

In determining the priority of projects, consideration is given to (1) the accident potential; (2) the traffic potential, both vehicular and rail; (3) the economic benefit to be derived; (4) the cost, and (5) the ability of the local governmental agency to finance its share of the cost.

The first list established included the elimination of the grade crossings on Harding Way. Harding Way is a main east-west arterial through the northern part of Stockton. Traffic at the crossing amounted to 15,000 vehicles and 49 train movements in a 24-hour period. This number of vehicular and rail movements presented a somewhat high accident potential.

Accident Rate Improves

The construction of the underpass has of course eliminated the train-vehicle type of accident and, in addition, will save many thousand dollars annually for the vehicle operator who no longer will be required to wait for trains to clear the crossings.

Since this underpass was completed and placed in full operation, vehicular traffic on Harding Way in the vicinity of these two grade crossings has shown a marked increase. This increase in traffic is due, for the most part, to vehicles using this route rather than existing grade crossings on each side of Harding Way.

Origin and destination trip analysis indicates 88,000 northeast-northwest quadrant transfers in 1975. The newly completed Harding Way Underpass and an inadequate underpass on Miner Avenue approximately 0.8 mile to the south will carry the bulk of this future traffic.

LARGE CONTRACT AWARDED

The State Department of Public Works has awarded a $12,625,800 contract for freeway construction on the Gold State and San Diego Freeways in the vicinity of San Fernando, north of Los Angeles.

L.A.R.T.S.

Continued from page 36 . . .

6. The land use models developed in this study will provide powerful tools to the local communities for testing and evaluating alternatives of existing and future land use and transportation plans. In addition, they furnish the kind of information needed by local authorities for orderly planning of vital community services such as sewer, water and street improvements.

Since this is a continuing study, additional information will be developed as needs arise regarding evaluation of alternate land use and transportation plans, alternate concepts of mass transit and freeway systems; together with any refinements in the methods of analysis, appraisals of the socio-economic factors affecting travel and understanding of land development.

Orderly Development Stressed

Legislators, planners, administrators, engineers and others are charged with the responsibility of ensuring the orderly development of the greater Los Angeles Area on a local and regional level. The problems of adequately meeting this responsibility grow more numerous and complex as this area rapidly coalesces into one super metropolitan region. It becomes increasingly clear that the knowledge and skills of social and scientific disciplines should be coordinated in a common effort to understand the interplay of forces shaping the development of this super-region. A key to this understanding lies in the proper evaluation of the interrelationships of land use and transportation.

The Los Angeles Regional Transportation Study offers the means for deriving and using these relationships through integrated land use and transportation planning. It offers a study procedure for investigating the whole region without submerging the unique characteristics of the individual local communities. It offers the tools and the understanding required for more effective community and regional planning—all within the framework of existing governments—through voluntary cooperation.

Legislators Attend Highway Budget Briefing



One veteran and five first-term State Senators met in the California Highway Commission conference room in the Public Works Building in Sacramento in mid-January for a briefing session on state highway planning and budgeting procedures. After Senator Randolph Collier, long-time chairman of the Senate Committee on Transportation, had set the stage, the legislators heard from State Highway Engineer J. C. Womack and members of his staff, then asked questions for the rest of a 90-minute session. In the group, left to right, are Senators Vernon L. Sturgeon, San Luis Obispo County; Aaron W. Quick, Imperial County; John C. Begovich, Amador and El Dorado Counties; Collier, Siskiyou and Del Norte Counties; Samuel R. Geddes, Napa and Yolo Counties (former Assemblyman); and Robert D. Williams, Kings County.

L.A. Bridge Engineer C. W. Jones Retires

Charles W. Jones, Supervising Bridge Engineer for the Bridge Department in Los Angeles, retired January 31, after more than 41 years of service.



CHARLES W. JONES

Jones began his career with the State in 1919 in Sacramento as a draftsman with the Division of Highways. Shortly after, he was assigned to the newly organized "small group" handling bridge work. He is practically a Charter Member of the Bridge Department and has served in virtually every section of the organization.

During his activities as Resident Engineer on bridge construction in Los Angeles he was given the additional job of opening the first Southern Office of the Bridge Department in 1926. He later served as Bridge Maintenance Engineer, Construction Engineer, Planning Engineer, and in 1957 he was appointed Special Studies Engineer for the Southern Office of the Bridge Department.

Jones was born in San Francisco and attended school in that city. He graduated from the University of California at Berkeley with a degree in Civil Engineering, and shortly afterward joined the Army and served during the first World War as a Lieutenant in the Coast Artillery.

Jones is a Fellow of the American Society of Civil Engineers and is presently Chairman of the Task Force on Hydraulics of Culverts.

Design Course

Bridge Department Conducts Own Correspondence Lessons

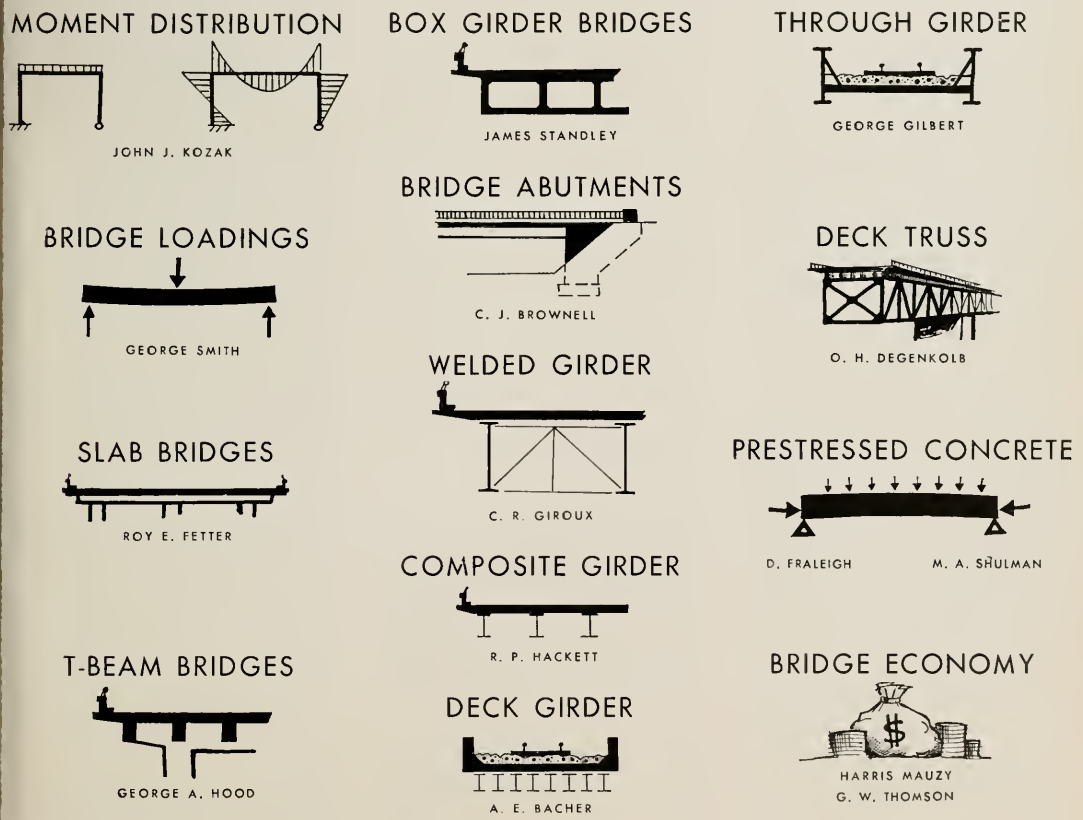
By WALTER W. WHITE, Associate Bridge Engineer

The month of June, 1960 saw the completion of the first correspondence course in Bridge Design Practice, and the issuance of 112 certificates of Completion to Bridge Department Engineers. A second offering of the course, now in progress, has an enrollment of approximately forty Engineers and is near completion. The course was authorized in the Bridge Department in response to a large number of requests by bridge men, about ⅔ of them in the construction phase of bridge engineering, and ⅓ in design.

The course is based largely on the "Manual of Bridge Design Practice," recently published and available for purchase. This manual is itself an outgrowth of a course given 7 years ago by a number of engineers organized by W. F. Pond, Supervising Bridge Engineer. However, the present course differs from the original one largely in that it is being given by correspondence, to accommodate the large number of field men showing interest. In addition to the Manual, supplementary material is also provided from time to time, as required.

Coordinoted Effort

That the course represents a coordinated group effort is well illustrated by the fact that the manual was originally produced by 25 differ-



The 13 lessons comprising the new "Bridge Design Practice" correspondence course are listed in the diogram above with the names of the instructors, all engineers in the Bridge Department.

ent engineers and that an equal number are now originating the individual lessons and checking the papers. Mailing, reproducing, overall coordination and supervision are being done by still other personnel. The interest shown and full cooperation by those participating has been very gratifying.

The main objective in providing this course has been, as the title of the manual suggests, to give the engineer practice in the designing of bridges. The course affords a transition between college and the everyday work of design. It is purposed to give the engineer ample practice in the application of engineering theory to actual specific bridge design, in this way converting his theoretical knowledge into working knowledge, helping him to be a more competent Bridge Engineer, whether in design or construction.

Moreover, it is purposed to acquaint the engineer further with bridge design specifications and the engineering phenomena which are peculiar to the design of bridges. It is a specialized type of course and has been made relatively complete in the belief that value derived is proportional to the time spent, provided it is spent on important subject matter. Emphasis is placed first on course value as a means of stimulating student interest, rather than brevity to fit the interest the enrollee may have.

Repetitive Problems Avoided

In order to accomplish these objectives with the least amount of labor on the part of those preparing and grading the course and also with the least effort on the part of the enrollee, repetitive parts of problems are avoided entirely, or pre-calculated values are given with the problem as required. This approach has further served to facilitate integration of the course with the normal work program.

A goal has been set at approximately 15 hours of homework per lesson (average). To this end a complete digest of the manual material was prepared, and the subject matter was divided as equally as possible among the 13 lessons to be given. Subject matter was selected which would emphasize the important differences in bridge types. It is estimated that the equivalent effort of 100 classroom hours, roughly equal to two, 3-unit college courses, was put forth by each engineer completing the 13 lessons.

Lessons by Mail

Lessons are mailed in, graded by designated bridge designers, and returned to the enrollee with appropriate written comments. Any unsatisfactory papers must be corrected and re-submitted for credit, and all 13 lessons must be completed.

The complete course, including both the problems and their solutions, is now being reproduced, to be distributed to holders of the Manual of Bridge Design Practice.

In addition to those completing the entire course, there are about 100 engineers who have successfully completed the first half of the course, which deals with the more basic concepts and most important bridge types. These men can continue this training later, through home study and by experience or by resuming the course at a future date.

It is believed that the 150 engineers who have completed, and who will shortly complete the course have received a solid background in the application of engineering principles to the design of bridges. With proper supervision they are now able to undertake the design of almost any type of bridge currently being used in the huge construction program of the Division of Highways.

Eureka Chief Clerk I. F. Cramer Retires

I. F. "Ferd" Cramer, Highway Chief Clerk of the California Division of Highways, District 1, in Eureka, will retire on December 30, 1960, ending a 40-year career in State service.

Cramer was born in Ogden, Utah and attended schools in Chicago, Illinois. His first job was with a department store in Chicago. Later he worked for the American Steel Foundry. Cramer was a member of the National Naval Volunteers and during World War I served at various naval aviation stations in the United States.



I. F. CRAMER

In 1919 he moved to California and settled in Willits, where he owned and operated a theater.

In 1920, he went to work for the State Division of Highways at Willits, where the District 1 Office was located at that time. His first assignment was as a draftsman. He transferred to the accounting section a few months later. He was promoted to Chief Clerk in 1927 and advanced through increasingly higher classifications of this title to head of all accounting functions for District 1.

His wife is the former Dorothy Upp of Willits. They have 12 children; 4 girls and 8 boys, and 14 grandchildren.

Highway User Taxes To Exceed $600 Million

California highway-user taxes for 1960 should be more than $610,000,000 according to an estimate, prepared by the Bureau of Public Roads, U.S. Department of Commerce, based on reports from state agencies and other sources.

Nationwide state highway-user tax figures are expected to reach approximately $5,300,000,000, thereby exceeding 1959 totals by five percent. Amounts paid by highway users in the various states will range from the high of $610,499,000 for California to a low of $4,487,000 for the new state of Alaska. New York will be the state next highest to California with an estimated total of $377,204,000.

California's total will include (approximately): $344,227,000 for motor fuel gallonage tax; $235,502,000 for motor vehicle registration fees; $6,616,000 for other motor vehicle fees; $16,880,000 for motor carrier fees; and $7,274,000 for miscellaneous fees.

"B" Section Chief Retires in L.A.

Emil Hanson, Assistant District Engineer in charge of District VII's Design "B" section, retired from the Division of Highways, on February 2. He had been with the State since 1929.


EMIL HANSON

Hanson was born in North Dakota and came west with his family in the early 1900's, settling in Pomona. He attended Pomona city schools, Los Angeles Polytechnic High School and the New Mexico School of Mines. During World War I he was a Gunner's Mate aboard the cruiser USS Cleveland assigned to convoy duty in the Atlantic Theatre.

His first professional job was on dam construction work in Esperanza, Sonora, Mexico. From 1924 to 1929 he worked for the City of Los Angeles in field and design engineering. His State service began in San Luis Obispo in District V. He then transferred to District VI in Fresno and was promoted to Assistant and Associate Highway Engineer. In 1937, he was assigned to the Headquarters office in Sacramento, where he advanced to Senior and then Supervising Highway Engineer. His last 11 years were spent in the District VII office in Los Angeles as head of Design "B", which encompasses all of Orange County and southeast Los Angeles County. He has been responsible for the design of such freeways as the Santa Ana, San Diego, Long Beach, Riverside, Newport, Artesia and Garden Grove.

Hanson's interest in Western Americana and pre- and post-Columbian Mexican History is taking him to San Miguel de Allende outside of Mexico City, where he and his wife will study Mexican culture.

If a vehicle begins to skid, the driver should reduce the power and turn the steering wheel in the direction of the skid until recovery begins.

IN MEMORIAM

District I

John L. W. Zumwalt, Highway Field Office Assistant.

District II

Floyd M. Sunde, Janitor

District IV

Albert F. Alcorn, Highway Equipment Operator-Laborer

District VII

Charles L. Gildersleeve, Senior Highway Engineer

Thomas F. Jesko, Highway Equipment Operator-Laborer.

Charles H. Snider, Highway Equipment Operator-Laborer.

District VIII

George C. Bradley, Highway Equipment Operator-Laborer.

George H. Radmore, Janitor.

District IX

Leece L. Pauly, Laborer.

District X

Newell R. Gill, Highway Field Office Assistant.

Carl M. Heynen, Associate Highway Engineer.

District XI

Jay F. Hanley, Laborer.

Charles H. Peck, Highway Foreman.

State-owned Toll Bridges

Tom F. Allison, Structural Steel Painter.

James I. Totten, Repairman, Reinforced Concrete Bridges.

Headquarters Office

St. Elmo C. Robinett, Assistant Research Technician.

Shop 3

Eugene R. Clifton, Highway Equipment Superintendent I.

Over 50 percent of the vehicular fires on the Ohio Turnpike are a result of overheated tires caused from under-inflation or improperly functioning wheel bearings.

Bridge Designer A. Eremin Retires

Anatol A. Eremin, Associate Bridge Engineer, retired on December 31, after more than 32 years with the State Division of Highways.

Eremin began his career with the Bridge Department in 1928. Among the structures he has designed are the Peninsular Avenue Overcrossing on the Bayshore Freeway in San Mateo, the first single-column bent bridge in California; the Waldo Tunnel on U.S. 101 north of San Francisco, one of the largest vehicular bores in the United States; the University Avenue Overcrossing on U.S. 101 in San Diego, the first concrete box girder bridge constructed in California; and the Gaviota Creek Bridge on U.S. 101 in Santa Barbara County, which has the largest skew of any arch bridge in the state.


ANATOL EREMIN

In 1954, he served as consultant on the design and construction of the Nuani Pali tunnels in Hawaii and received high commendation for his work from the Territorial Government.

Born in Samara, Russia, Eremin received his B.S. degree in civil engineering from the Petrograd Institute of Ways and Communications in 1917. After two years in the construction of railroad bridges he moved to Shanghai, China, where he worked as a structural engineer. He came to the United States in 1922 and received an M.S. degree from the University of California at Berkeley in 1924.

Eremin is a member of the American Society of Civil Engineers. He is the author of three engineering books and numerous engineering treatises.

Eremin is an artist-member of the Northern California Art Association. Eremin and his wife, Claudia, plan to reside in Berkeley. They have three married daughters and four grandchildren.

25-YEAR AWARDS ANNOUNCED FOR 25 EMPLOYEES

Headquarters Office
Mervyn R. Blacow
Wilfred R. Penfold

District I
Ivan G. Lawson
Ralph C. Russell

District II
William J. Watt

District III
Roderick J. McLeod
Raymond L. Rusk

District IV
Edward W. Gustafson
Roy E. Hansen

District VI
Veydon G. Cramer

District VII
Byron V. Hauger
Louis E. Steele

District IX
Henry R. Scott

District X
Edgar D. Latour

District XI
Robert R. Goodell
Carson McNamee
Earl L. Petersen

Materials and Research Department
John L. Beaton

Bridge Department
James O. Darr
Theodore W. Rodgers

State-owned Toll Bridges
Austin W. Talbot
Arthur Fross

Headquarters Shop
Ray N. Henderson

Shop 8
John Everett Ford
George C. Ulrich

W. J. Lambert, Jr.

William J. Lambert, Jr., Associate Right of Way Agent with the District III Office of the Division of Highways in Marysville, died December 20 after a long illness.

Lambert started in with Highways in February, 1956, as a Junior Right of Way Agent. He was promoted to Associate Right of Way Agent in September, 1959. He was in charge of the District's Land Economics Studies Section at the time of his death. A native of Sacramento, Lambert attended local schools and was a 1955 graduate of the University of California where he was a Political Science major.

Lambert was active in community and church affairs and, at the time of his passing, was President of Peach Bowl Chapter 40, C.S.E.A. He was a member of the American Right of Way Association.

He is survived by his wife, Patricia, of Yuba City.

ARROYO SECO

Continued from page 63 . . .

in charge of District VII, that it is very unlikely in the foreseeable future that there will be any major reconstruction on the Arroyo Seco Parkway because there are too many vitally needed new freeways to be built before funds will be available to carry out major reconstruction to improve existing freeways. It is Telford's view that completion within the next few years of the Glendale Freeway to the west and the extension of Long Beach Freeway to the east will, to a very considerable extent, tend to keep the Arroyo Seco Parkway from becoming further overloaded.

The Arroyo Seco Parkway has given excellent traffic service for 20 years past and can be expected to do so for many years in the future. As the situation now stands, it can easily be proved that this 20-year-old freeway has paid for itself many times over. It is as Telford has said: "We do not need to apologize to anyone about the Arroyo Seco Parkway."

Former Commissioner Dies in San Gabriel

Newell Dyke Darlington, 86, former member of the original State Highway Commission, died at his home at 562 N. Darlington Avenue, San Gabriel on November 27, 1960.

Appointed in 1911 by Govetnor Hiram Johnson as a member of the first California Highway Commission, he served in that capacity until January 8, 1923, when he retired from State service.

The first meeting of the highway commission was held in Sacramento on August 9, 1911. At that time Darlington, with Charles D. Blaney of Saratoga and Burton A. Towne of Lodi, the other members of the three-man commission, and Austin B. Fletcher, State Highway Engineer, assumed the responsibility for making the surveys, plans and construction for the foundation of the vast California State Highway System.

Born in January 1874, he was raised in Pennsylvania and came to California soon after graduation with a degree in civil engineering from Lafayette College in Easton, Pennsylvania in 1895.

In 1909 he was appointed a member of the City Public Utilities Commission of the City of Los Angeles, and later was commissioner of the City Board of Public Works, from which position he resigned June 30, 1911, to become one of California's first three State highway commissioners.

LARGEST PRODUCTION YEAR

Project allocations to construction for which plans were developed by Division of Architecture personnel exclusively totaled $92.6 million for 1960, the largest production year of record in Division history. Of this amount, $33½ million was completed during the last quarter of the year, second only to a 13-week period ending August 18, 1958, when $35½ million completed established the all-time record.

Use recommended tire pressures for best tire performance on ice.

Principal Engineer R. R. Rowe Retires

R. Robinson Rowe, Principal Bridge Engineer in charge of special studies for the California Division of Highways retired on November 30 after an engineering career covering 40 years, 26 years of it in State service.



R. ROBINSON ROWE

Rowe began his state career as a construction engineer on the San Francisco-Oakland Bay Bridge in 1933. From 1937 to 1938 he worked as a hydroelectric engineer with the U. S. Forest Service in Juneau, Alaska, after which he rejoined the California Division of Highways. He was put in charge of special studies for the Bridge Department in 1955 and was promoted to Principal Engineer in 1956.

A specialist in hydraulics, Rowe has written many articles which have appeared in national engineering magazines. He is co-author of a widely known book, "California Culvert Practice" and was co-ordinator of a recent study of slides in the Pacific Palisades area in Los Angeles. His most recent research project involved the compilation of a treatise on stream bank protection based on cooperative studies. He is probably best known, however, as the author of the "N. G. Neare's Column" a mathematical puzzle feature which began in "Civil Engineering" magazine in 1940.

Rowe is listed in "Who's Who in America" for 1958-9, "Who's Who in Engineering" for 1942 and "American Men of Science" for 1948.

Rowe was born in Spencer, Massachusetts and received his preliminary schooling in Paris Township and Grand Rapids, Michigan. He graduated from Harvard University cum laude in 1916 and, two years later, was awarded concurrently a degree in engineering from Massachusetts Institute of Technology and one in civil architecture from Harvard. He served with the U. S. Army from 1918 to 1919 and was a member of the Army Reserve from 1920 to 1940.

Rowe was in private engineering and business until he joined the state in 1933.

He is past president of the San Diego and Sacramento sections of the American Society of Civil Engineers and was a national director of the organization from 1955 to 1958. He is also past chairman of the Engineering Council of the Sacramento Valley.

He is a member of the National Society of Professional Engineers, American Geophysical Union, American Association for the Advancement of Science, Structural Engineers Association of Central California, International Society of Soil Mechanics and Foundation Engineering, International Association for Hydraulic Research and Highway Research Board. Rowe is also a Mason and a member of Chi Epsilon and Lambda Chi Alpha fraternities.

Rowe and his wife, Edythe, have a daughter and two sons. After retirement, he intends to devote most of his time to professional writing and will continue his current column in "Civil Engineering" called "Examgems" which he authors under the name of "Reggie Strashn."

RECENT RETIREMENTS FROM DEPARTMENT ARE LISTED

District I

Felix O. Barney, Laborer, 22 years; Hugh Edgmon, Light Power Shovel Operator, 35 years; Andrew C. Moore, Highway Equipment Operator-Laborer, 32 years; Wesley H. Stowe, Highway Equipment Operator-Laborer, 38 years.

District IV

Fred Merango, Laborer, 27 years; James O. Orr, Associate Highway Engineer, 13 years; * Fernand A. Abert, Highway Leadingman, 28 years; Harold F. Greene, Highway Foreman, 21 years.

District V

Roy H. Burger, Assistant Highway Engineer, 31 years; Claude C. Cushwa, Assistant Highway Engineer, 7 years.

* Disability

District VII

Raymon E. Harden, Highway Engineering Technician, 5 years; Harold W. Leonard, Principal Right of Way Agent, 31 years; Oscar E. Poplin, Highway Equipment Operator-Laborer, 27 years; * Gale G. Sphon, Highway Traffic Signal Technician, 12 years; Elton F. Wagner, Deputy Chief Right of Way Agent, 32 years; * Bengt I. Ericksson, Engineering Aid II, 3 years; Feramorz H. Young, Highway Chief Clerk II, 24 years.

District VIII

Theria D. Lambert, Highway Equipment Operator-Laborer, 31 years; Wilfred L. Savage, Highway Superintendent, 33 years; Ted C. Yeager, Highway Foreman, 23 years; Lawrence N. Backus, Highway Leadingman, 29 years; Edward R. Little, Highway Field Office Assistant, 7 years; William R. Peacock, Highway Foreman, 34 years.

District IX

Martha E. McFarland, Accounting Technician II, 32 years.

District X

William L. Hurd, Senior Highway Engineer, 32 years; Clifford J. Temby, Supervising Highway Engineer, 46 years; Joseph E. Halloran, Assistant Highway Engineer, 18 years.

District XI

Carl O. Reinius, Assistant Highway Engineer, 30 years; John C. Webb, Supervising Right of Way Agent, 20 years.

Bridge Department

Anatol A. Eremin, Associate Bridge Engineer, 32 years; * Francis M. Morrill, Associate Bridge Engineer, 26 years; * Ralph W. Riley, Foundation Driller, 2 years; R. Robinson Rowe, Principal Bridge Engineer, 26 years.

State-owned Toll Bridges

* Walter T. Berg, Toll Collector, 9 years.

* Disability

. . . Continued on page 74

Senior Engineer Paul Hine Retires

Paul Hine, Senior Highway Engineer with District VII Maintenance Department, has retired after 24 years of service.

He was born in Junction, Illinois, in 1906 and attended primary and secondary schools in Junction and Dallas, Texas.



PAUL M. HINE

He began his engineering career as chainman for private surveyors in Los Angeles in 1927, having come to California in 1924. Until 1936, when he joined the State Division of Highways, he was employed by the County Surveyor's office, Riverside (1927-29); the Southern Sierra Power Company (California Electric Power Company) as transitman and map draftsman (1929-32); and the City of Riverside as engineering draftsman (1932-36). His State service began in District I, Eureka. In 1941 he transferred to District VII, where he worked in Maintenance, Hydraulics, Design and Construction, becoming a senior highway engineer in October, 1956.

Paul Hine pioneered hydraulic model work in District VII and made important contributions in the design of drainage drop structures.

Hine has a son, Lt. (j.g.) Paul M. Hine Jr., and a daughter, Mrs. Albert C. Ordway, of Monterey Park. He plans to move to Apple Valley.

RECENT RETIREMENTS

Continued from page 73 . . .

Shop 6

Leonard C. Fisher, Heavy Equipment Mechanic, 10 years; Lloyd A. Peet, Laborer, 8 years.

Shop 7

Clyde B. Barnes, Automobile Mechanic, 42 years.

Shop 11

Lillian E. Munnings, Accounting Technician II, 21 years.

Median Barrier Tests Win National Honors

A State Division of Highways research project won national honors at the annual January meeting of the Highway Research Board of the National Academy of Sciences in Washington D. C.

The study, entitled "Dynamic Full Scale Tests of Median Barriers," was made under the direction and supervision of J. L. Beaton, supervising highway engineer, and R. N. Field, materials and research engineering associate, both of the Division's Materials and Research Department in Sacramento.

It was selected for the honorable mention award as one of the three best papers presented at the Highway Research Board's 1960 meeting. Several hundred research papers are presented to the board each year.

The Beaton-Field research project involved the testing and evaluation of 15 different types of freeway median (center strip) barriers. Included was a spectacular series of crash tests using radio-controlled vehicles and an electronic dummy.

Purpose of the study was to find barrier designs which prevent vehicles from crossing the center strip and also minimize the severity of collisions with the barrier and reduce the threat of ricochet into the traffic stream.

Two types of barriers new to California highways were developed—the fence-cable barrier and the blocked out metal beam barrier. Both types have since been installed on sections of several heavily traveled freeways.

A summary of the study report appeared in the July-August, 1959, issue of *California Highways and Public Works*.

The last Division of Highways paper honored by the board was in 1957. The top winner then was a study entitled "California Freeway Capacity Study, 1956," by George M. Webb, Traffic engineer, and Karl Moskowitz, assistant traffic engineer.

In 1949, Francis N. Hveem, materials and research engineer, and Robert M. Carmany, assistant engineer of design, received the award for "The Factors Underlying the Rational Design of Pavements."

Rex H. Fulton

Rex H. Fulton, Senior Highway Engineer in charge of aerial surveys (Photogrammetry) for the State Division of Highways, died on January 11, following an illness of several months. He had retired from State service on December 31.

He went to work for the Division in the District V Office, San Luis Obispo, as acting resident engineer and Maintenance Superintendent in 1930 and transferred to Headquarters Office in Sacramento in 1933. He was appointed Associate Highway Engineer in charge of priorities and war surplus purchases in 1942. When the Service and Supply Department was organized in June 1947, he became Administrative Assistant of the department. In 1952, he was put in charge of the Photogrammetry Section which prepares plans and specifications, awards contracts, establishes standards of accuracy, consults contractors and other government agencies on aerial survey problems. He received commendation from the American Congress on Surveying and Mapping for his work in photogrammetry.

Fulton was born in Centralia, Washington, and attended school there. He studied Civil Engineering at University of Washington. His first job was as a logging engineer and topographical engineer in Portland. In 1929, he went to work for the City of Chico as a property appraiser.

He was a member of the American Society of Civil Engineers and the American Society of Photogrammetry.

Fulton is survived by his wife, Ersel; sisters, Mrs. Marvel Robinson of Spokane, Washington; Mrs. Garnet Bohannan of Seattle, Washington; and brothers, Mr. Fred Fulton, Santa Barbara; Harry Fulton, Olympia, Washington; and John Fulton of Toledo, Washington.

Rex Whitton Is New Federal Roads Chief

Rex Whitton, 62, former chief engineer of the Missouri State Highway Commission, is the new Federal Highway Administrator.

Whitton was appointed to the federal post by President John F. Kennedy. He succeeded Bertram D. Tallamy, who had headed the federal road-building program since 1957.



REX WHITTON

Whitton had been associated with the Missouri Highway Department since 1920. He became chief engineer in 1951. He is former president of AASHO and a former chairman of the Highway Research Board.

Whitton recently won the Thomas H. MacDonald Award for "outstanding service in highway engineering" which is presented annually by the American Association of State Highway Officials.

Whitton was the fourth person to be given this honor. The 1958 recipient of the award is G. T. McCoy, retired State Highway Engineer in California.

William A. Bugge Is New HRB Chairman

William A. Bugge, Director of Washington Highways, was elected chairman of the Highway Research Board for 1961, succeeding Pyke Johnson.

Bugge has served as Director of Highways in Washington State since 1949, and is a past president of the American Association of State Highway Officials.

The Highway Research Board was organized in 1920 to encourage research in highway matters as well as to provide a national clearing-house and correlation service for research activities and information on highway administration and technology. The Board operates under the auspices of the National Research Council and consists of 45 technical and commercial associations as well as 1300 non-voting associates.

Robert Van Stan Retires in L.A.

Robert W. Van Stan, Senior Highway Engineer in the District VII Traffic Department, has retired after 37 years of State service.

He was born in Seattle on November 20, 1898, and attended public schools in Alameda, California. After a stint in the Army in 1918, he enrolled in the University of California at Berkeley. He was graduated in electrical engineering in 1923, at which time he entered State service with the Division of Highways in District II, Redding (Dunsmuir), in survey and construction work.



R. W. VAN STAN

Succeeding years found him in construction and the Bridge Department as assistant and resident engineer, including 1933-36 on the San Francisco-Oakland Bay Bridge.

In 1936 Van Stan returned to the Southern Area Bridge Department where he remained as resident engineer on various projects until 1942, when he was called to active duty in the Navy Civil Engineer Corps. As Lt. Commander and Commander (1943), he was in charge of construction of airfields, buildings, etc., in sections of the South Pacific. In 1945, he rejoined the Southern Area Bridge Department at Los Angeles, transferring in 1946 to the District VII Traffic Department. He has remained with this department until his recent retirement. He was appointed Senior Highway Engineer in 1948.

Van Stan holds California Civil and Electrical Engineering licenses and is a member of the Illuminating Engineering Society. He and his wife reside at 791 St. Katherine Drive, Flintridge, California.

G. T. McCoy Receives Golden Beaver Award

George T. McCoy, former State Highway Engineer, was the recipient of the Sixth Annual Golden Beaver Award for Engineering.

The presentation was made to McCoy in Los Angeles on January 19 by Paul Grafe, President of the Beavers, a national fraternity of leaders in the construction field.

Other Golden Beaver awards went to T. E. Connolly, head of T. E. Connolly Inc. and the Connolly Pacific Company, in the field of management; David E. Root, retired vice-president of the Guy F. Atkinson Company in the field of supervision; and John L. Savage, consulting engineer and former chief designer for the U.S. Bureau of Reclamation, a special award.

In making the award, Grafe said:

"When George T. McCoy retired from his long tenure as Chief of the California Division of Highways in the autumn of 1959, he left a record of engineering accomplishment few can equal. During his 16-year administration he directed the activities that revolutionized highway travel in California by creating 2300 miles of multilane, divided highways, a project whose size can be better imagined by the fact that it involved expenditures of two and a half billion dollars. The speed and efficiency with which the vast expansion was brought has established California as the home of modern freeways and the example for the other parts of the nation."

McCoy joined the State Division of Highways in 1927. A graduate of Whitman College in Walla Walla, Washington, McCoy also holds a degree in civil engineering from Columbia University awarded him in 1915. Much of his early career was spent with the Washington State Highway Department where he held the position of Assistant State Highway Engineer prior to coming to California.

On winter roads, pump brakes to reduce skidding, maintain steering control and shorten stopping distance.

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leaving state service, he will be in charge of the association's new national office in Los Angeles.

Balfour has also taken part in the activities of the American Association of State Highway Officials. For 12 years he headed the AASHO standing committee on right of way.

He was born in Pomona in 1894 and received his early education there. He attended St. Vincent's College in Los Angeles and received a bachelor of science degree in electrical engineering from the University of Santa Clara in 1914.

He was employed by the Southern California Edison Company and the J. G. Braun Company and later became a real estate broker in the Los Angeles metropolitan area.

Balfour joined the Division of Highways in 1931 as an assistant right of way agent. He was appointed chief right of way agent in 1943.

He is a member of the Sacramento Rotary Club and has been prominent in local civic and welfare activities.

Balfour and his wife, Clare, plan to make their home in Los Angeles following his retirement.

Hess is a native of Valley Ford, Sonoma County, and was educated in San Francisco, studying engineering at Healds College there. He went to work for the Division of Highways in 1929 as a junior engineering aid in the Fresno district. The following year he transferred to the San Francisco district, working in right of way engineering and in construction inspection.

He shifted from engineering to right of way work in 1944 and moved to Division Headquarters in Sacramento in 1947 as an associate right of way agent.

His accomplishments include the development of the Division's Land Economics Section, whose studies of the economic effects of freeways have received nationwide recognition; editing the first right of way manual in the nation; and inaugurating an intensive program of in-service training for right of way agents.

For the past four years Hess has been in general charge of right of way acquisition and related matters in Central and Northern California.

He is a member of the American Right of Way Association and national chairman of its land economics study committee; a member of the Society of Residential Appraisers; and the Commonwealth Club of San Francisco.

Hess and his wife, Louise, reside in Sacramento. A daughter, Mrs. Toni DeFriese, lives in San Francisco.

MacBride, the new Assistant Chief Right of Way Agent, came to California in 1945 from Norfolk, Virginia, where he was raised. He attended the College of William and Mary, received a Bachelor of Laws degree from Cumberland University, and also attended the Medill School of Journalism at Northwestern University.

He practiced law and gave speech instruction in Virginia until he moved to Los Angeles as a right of way agent for the city. In 1946 he became an assistant right of way agent for the Los Angeles District of the Division of Highways. He transferred to Division Headquarters in Sacramento in 1956 as a Supervising Right of Way Agent.

MacBride is national secretary of the American Right of Way Association and a member of its executive committee. He is vice president of the Public Relations Round Table of Sacramento and a member of the Audubon Society. He and his wife, Margaret, live in Sacramento.

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C. J. "Cliff" Temby Retires in Stockton

Clifford J. Temby, Assistant District Engineer of District X, Stockton, retired December 1, 1960 after 46 years with the State Division of Highways. He entered State service at Sacramento in 1914 in the Department of Engineering, California Highway Commission. He has held numerous assignments in the Headquarters office in Sacramento; District III, Marysville; District V, San Luis Obispo; District IX, Bishop; and District X, Sacramento, until 1933 when district headquarters was moved to Stockton.



C. J. TEMBY

During Temby's professional life, he has seen California's highways advance from the horse and buggy era to a modern freeway system serving millions of Californians and tourists. For some thirty years as Office Engineer and Assistant District Engineer he supervised the planning and location of many projects throughout the State whose total value is in the neighborhood of half a billion dollars.

His long service record in District X has earned him the title of "Mr. Highway" among civic and service groups in the nine counties of the district.

He plans to continue his residence in Stockton after his retirement and spend some time traveling in the U. S. and abroad.

BURNED BRIDGE CLOSES ROAD

A major road closure occurred on US Highway 60-70 in eastern Riverside County as the result of the destruction by fire of Segal Wash Bridge about 17 miles east of Desert Center. The highway was closed from 4 p.m. December 23 to 3:45 p.m. December 25 while an adequate local detour was being constructed. During the period of closure it was necessary to detour traffic via the Los Angeles Aqueduct Road.

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THEN

The road paving job above was mainly muscle power—both horse and man muscles. This was about 1914, when mechanization was in its infancy. Horses pulled wagons carrying gravel from the borrow pit, a horse pulled the Fresno scraper seen in the background working on the grade, horses even had to pull the mixer to a new position when it was necessary to move it. The only evidence of mechanization is the mixer with its gasoline engine to turn the drum, and the steam roller in the background.

Each mix was about eight or ten wheelbarrow loads (one and a half cubic feet per wheelbarrow), wheeled to the skip by laborers. The big plank with the plow handles on it was used for finishing. The lower edge was cut slightly concave on the under edge to give the road a crown, and a man at either end slid it along.

The modern dual drum mixer shown below moves along and outside the forms, delivers a yard and a half batch about every half minute. Multibatch trucks unload one batch at a time directly into the skip, moving with the mixer. The entire train moves steadily along the job, with the mixer towing its own water tank.

The old type method above would do well to pave 150 feet a day—modern machines do 2,000 feet or more, 24 feet wide, with a better and smoother job.

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CALIFORNIA Highways and Public Works

MARCH-APRIL 1961



Looking west along the completed section of the Ventura Freeway in the San Fernando Valley. The view is from Hazeltine Avenue. *(See article "District VII" beginning on page 3)*

California Highways and Public Works

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FRONT COVER—Looking south on the San Diego Freeway through the City of San Clemente, Orange County. The photo shows the modern type of freeway signing used in California, including the Interstate Route and US route signs. This section of the San Diego Freeway was opened to traffic last November (See "District VII" beginning on page 3).

Photo by John F. Meyerpeter



BACK COVER—An architectural study of the ventilation building portal of the Hazelview Summit Tunnel on US 199 now under construction. The view is southwest toward Gasquet, Del Norte County. The completed tunnel will be more than 1,800 feet long with a 26-foot-wide roadway.

Drawing by W. H. Ludlow, Bridge Department

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SACRAMENTO, CALIFORNIA

S.F. Vista

Temporary Sightseeing Area Installed On Section of Embarcadero Freeway

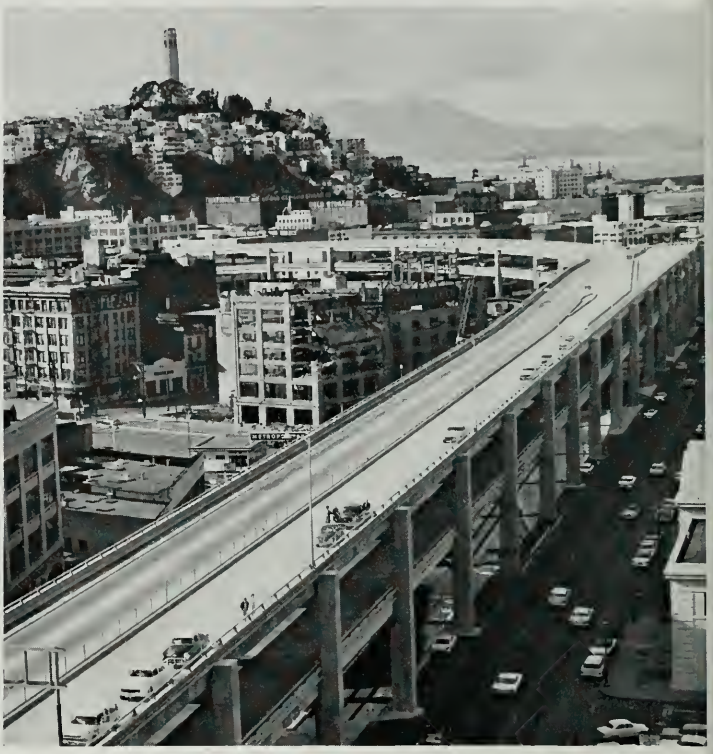


THE DOUBLE-DECK Embarcadero Freeway in San Francisco was designed and built to carry four lanes of traffic on either deck, but until connecting sections are built it is operating far below capacity.

In August, 1960, Governor Edmund G. Brown approved a plan for temporarily converting part of the upper deck into a vista area for sightseers. A contract for the installation of protective fencing and timber curbs was completed on January 26, 1961, at a construction cost of $28,000.

There are 60 parking places provided, along with strolling areas. Motorists reach the area on the north side via the on-ramp from Broadway and Sansome Streets, and leave at the south end, using the ramps which connect to the Bay Bridge and the James Lick (Bayshore) Freeway.

Experience during the first few weeks indicated that weather and special events will be major factors in the amount of use the area receives. The arrival and departure of a new luxury liner was viewed by quite a few motorists from the upper deck vantage point.



A view of the Embarcadero Freeway from the Ferry Building, showing the fenced-off vista area on the upper deck; Telegraph Hill and Coit Tower in the background.

LOWER LEFT—Four officials inspect the vista area on its opening day: left to right, Assistant State Highway Engineer J. P. Sinclair, San Francisco Chief Administrative Officer Sherman P. Duckel, San Francisco Mayor George Christopher, and State Director of Public Works Robert B. Bradford.
LOWER RIGHT—View of the entrance to the vista area from the Broadway on-ramp, looking toward the Ferry Building and the S.F.-Oakland Bay Bridge.





District VII

Freeway Completions, Current Construction Add Up To Encouraging Progress Picture

By E. T. TELFORD, Assistant State Highway Engineer



DISTRICT VII, comprising of Los Angeles, Orange and Ventura counties, is largely a metropolitan community. Since 1940, when it had 1,314,000 motor vehicles and a population of 2,986,000, the District has grown to a motor vehicle registration of 3,840,000 and a population of 6,942,000. By 1980 it is anticipated motor vehicles and population will again double their numbers.

The metropolitan area can continue to grow only if it serves its proper purpose as a center of activity. To serve that purpose it must have facility of communication and transportation.

In the total plan of the metropolis, planning for transportation must consider the size and general scale of tomorrow's metropolitan area and distribution of the population needs. As a part of the transportation field, we are concerned with the metropolitan highway plan and primarily with the "freeway system."

The freeway system, a basic unit in an integrated system for motor ve-



Long Beach Freeway terminus. Connections to Long Beach City Street System south of Anaheim Street, bottom.



Freeway Progress. The obove map shows the current status of freeway construction in the District VII area. Compare this with the map on the following page.

hicle transportation, offers no direct land-use service. It is through the major arterials, collectors and local land-service roads that the road network becomes a complete system. The effectiveness of the total system depends upon the proper balance between its parts.

Long-range planning is essential to the metropolitan freeway system, and it must have a sound basis in legislation. The California Legislature has maintained a long history of sound legislation, beginning around the turn of the century and most recently culminating with the enacting of Senate Bill No. 480 in 1959. This long-range framework of routes to be developed as freeways is essentially a framework of the future.

By Senate Bill No. 480, the Legislature has already provided for about 1,500 miles of the California freeway system in District VII. The California Highway Commission has adopted about 714 miles of these routes in this district.

At the close of 1960, the District had a total of $171,608,500 under contract on state highways and freeways covering a gross mileage of 163.4. During the 1960 calendar year the public received the use of another 25.5 miles of freeways representing a construction cost of $42,950,000.

On the Golden State Freeway the sections between Sixth Street and Pasadena Avenue in Los Angeles were completed in March, 1960. The Harbor Freeway between 124th Street and 190th Street was completed in August.

The San Diego Freeway between Jefferson Boulevard and Venice Boulevard was completed in July. Two sections of the Ventura Freeway were completed in April and May for the respective portions between Laurel Canyon Boulevard and San Diego Freeway, and between Encino Avenue and Kelvin Avenue.

In Orange County, in December a section of the Pacific Coast Freeway between the San Diego Freeway and Serra Junction was completed in conjunction with the San Diego Freeway between Avenida Ramona in San Clemente and Ortega Highway in San Juan Capistrano. In addition, the Riverside Freeway between Harbor Boulevard (formerly Spadra Road) and Placentia Avenue in Fullerton and Anaheim, was completed in January, 1960.

In addition, it is expected that 12.5 miles of freeway will be opened in 1961 and 62.9 miles in 1962.

The District now has the beginnings of a usable freeway system. The separate units of the system and the status of development on each unit or freeway follows:

Antelope Valley Freeway

The entire 54.5-mile length of the Antelope Valley Freeway (U.S. 6) was adopted by the California Highway Commission in the years 1955-56-57. Right of way expenditures at the close of 1960 amounted to $697,000.

The Antelope Valley Freeway is an important highway in the northern part of Los Angeles County. This freeway will serve the High Sierra recreational areas as well as the governmental facilities of the U.S. Naval Ordnance Test Station at China Lake, Flight Test Center at Edwards Air Force Base and Air Force Plant 42 at Palmdale. It has also been designated as an escape route in case of atomic attack on metropolitan Los Angeles.

In March, 1956 the California Highway Commission adopted as a freeway portions from the Golden State Freeway to Solamint and from Vincent south of Palmdale to Avenue D, north of Lancaster. Because additional studies were required to establish an economical alignment through the rugged terrain from Solamint to Vincent, adoption of this segment was delayed until November, 1957. Standards for highway construction are continually being improved; therefore, studies are now under way for a more economical location of the portion from the Golden State Freeway to Solamint.

Bids for the initial construction project were opened on November 3, 1960, and the contract was awarded on December 1, 1960, for a low bid of $7,168,660.

The project calls for grading of the roadbed, drainage structures, frontage roads, and realignment of existing county roads. The one item of road-

way excavation (7,700,000 cubic yards) accounted for nearly 56% of the total value of the bid submitted.

This project extends from Sand Canyon (approximately 9 miles north of the city limits of Los Angeles) for 10 miles to Escondido Canyon Road. The first portion of the project parallels the Santa Clara River to Lang. At this point it begins to traverse the rugged terrain across Agua Dulce Canyon Road and near Vasquez Rocks, reported in early California history as the bandit Vasquez' hiding place.

In an effort to place a usable facility in operation at the earliest possible time, the California Highway Commission has provided an additional $8,000,000 in the 1961-62 construction budget to pave the initial grading project, construct bridge structures, and complete the freeway from Solamint to Red Rover Mine Road, a distance of 16 miles. The estimated completion date for this project is April, 1963.

As funds become available, additional segments of the Antelope Valley Freeway will be constructed. When completed from the Golden State Freeway near Los Angeles to the Kern County line, expenditures in excess of $60,000,000 will have been made.

Artesia Freeway

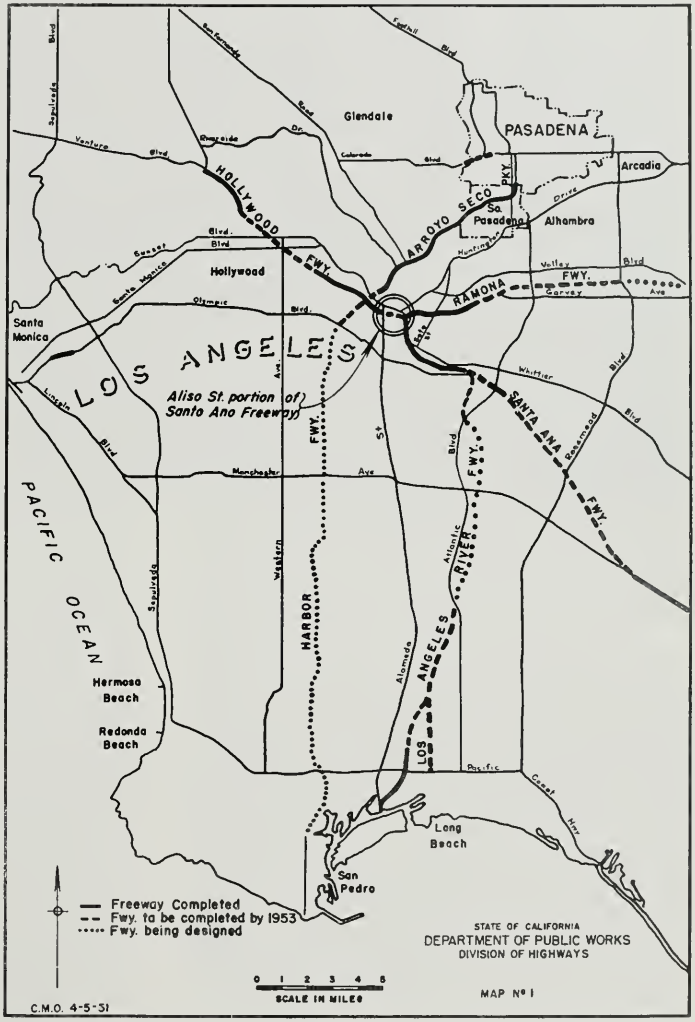
The Artesia Freeway (State Sign Route 14) takes its name locally from Artesia Street along which it follows for a considerable distance in Los Angeles County. It is a part of the route that extends from Pacific Coast Highway (U.S. 101 Alternate) in Redondo Beach easterly into Orange County.

The State Highway Commission has adopted two portions of this route as freeway. One of these extends from Normandie Avenue to Santa Fe Avenue, and the other from Palo Verde Avenue to the Santa Ana Freeway. The total distance of freeway adoption is 12.4 miles. Of this, 4.9 miles have been constructed to expressway standards at a cost of $2,324,000. The extension of this route in Orange County easterly of the Santa Ana Freeway is known as the Riverside Freeway.

Design studies are currently in progress for the conversion of the expressway section between Normandie Avenue and Alameda Street to full freeway standards. Between Alameda Street and the Santa Ana Freeway, a distance of 14 miles, contract plans are being prepared for ultimate 8-lane freeway construction. Right of way expenditures to date, for the entire adopted route, amount to $5,272,000.

Beverly Hills Freeway

Studies are in progress for the Beverly Hills Freeway between the San Diego Freeway near Westwood and the Hollywood Freeway. Extensive research is being conducted for this project in land-value study zones in order to provide comparable estimates of right of way needs for alternate possible alignments. It is anticipated that the studies will be completed pre-



District VII freeways in 1953. The above map shows the sections of freeway completed or under construction seven years ago. Compare this to the map on the preceding page.



Looking southwesterly from Soledad Canyon Road at construction in progress on the Antelope Valley Freeway adjacent to Santa Clara River.

paratory to a public meeting sometime in early 1962.

Century Freeway

The Advance Planning section is actively studying the Century Freeway between Lincoln Boulevard (U.S. 101 Alternate) near Inglewood and the Santa Ana Freeway near Norwalk. Meetings were held with the Century Freeway Association on April 20, 1960 and July 21, 1960, at which these studies were discussed. Also, in connection with route location research for this freeway, a post card origin and destination survey was undertaken at the Los Angeles International Airport on October 26 and 27, 1960. It is expected that a regular public meeting can be held in early 1962 for that portion of the route between the Harbor Freeway and Lincoln Boulevard. Public meetings for the section east from the Harbor Freeway to the Santa Ana Freeway will follow at a later time.

Colorado Freeway

A part of the Colorado Freeway (State Sign Route 134) has been completed since 1955, at a total right of way and construction cost of $8,600,000. The 2.3-mile section extends from Eagle Vista Drive in Eagle Rock to Holly Street in Pasadena. This route will eventually connect with the Golden State Freeway on the west and the Foothill Freeway on the east. Several public meetings have been held on the unadopted portions of the Colorado Freeway, with the most recent being on October 8, 1959, on the District level, followed by a California Highway Commission hearing on October 27, 1960. The results of these meetings dealing with the location of the route west from Club Road in Eagle Rock through Glendale to the Golden State Freeway, have been under study by the California Highway Commission, who on February 23, 1961 adopted a final route. The adopted line measures approximately 6.6 miles and will cost an estimated $29,000,000 for rights of way and construction.

Corona Freeway

The Corona Freeway (State Route 71) in District VII is completed to 4-lane expressway standards for a distance of 3.2 miles from 5th Street in Pomona to Riverside Drive at the San Bernardino County line, at a total cost of $1,068,000. Plans have been completed to convert this route to full freeway standards northward as far as the San Bernardino Freeway, an over-all distance of 4.4 miles. Estimated cost of the conversion is $2,500,000, which must await future financing. Grade separation bridges and interchanges will be required at Holt Avenue, Valley Boulevard and Fifth Avenue. Existing bridges over the Southern Pacific Railroad and the Union Pacific Railroad will have to be widened.

Corona Del Mar Freeway

The Corona Del Mar Freeway (Route 184) in Orange County was adopted in 1940 as a freeway between Pacific Coast Highway and the Newport Freeway, a distance of 6.3 miles. In 1942 the southerly 2.3 miles, between Pacific Coast Highway and Buffalo Ranch Road, was completed as a 4-lane divided highway and the remaining 4 miles as a 2-lane facility, at a total cost of $283,000. Preparatory to the design of a 6-lane freeway over this route, on October 3, 1960 an aerial survey contract was awarded for contour mapping between Pacific Coast Highway and just south of Palisades Road.

The Advance Planning section, at the request of the Orange County Board of Supervisors, is resudying this line. The Supervisors' request was made because of the conflict between a proposed extension of the existing Orange County Airport runway and the present route. It is anticipated that

a public meeting to discuss the various alternates can be held by the end of this year.

Palmdale Boulevard

Palmdale Boulevard (State Sign Route 138) is the major east-west route through the Antelope Valley.

During 1960 two separate contracts were awarded for much needed construction on this route. The first contract between 1.5 and 4.4 miles east of Palmdale was awarded on July 21, 1960. This 2.9-mile project consists of widening the existing 2-lane to a modern 4-lane divided facility with channelization for left turn movements. This project, under $479,800 contract is scheduled for completion in the near future.

The second contract, between 6th Street East and Sierra Highway (U.S. 6) was awarded on August 12, 1960, and completed in December. This 0.1-mile project also consisted of widening to a 4-lane divided facility with left turn channelization and included widening of the existing railroad crossing and construction of ties. This project, costing approximately $106,-800, was jointly financed between the County of Los Angeles and the State.

The completion of these two projects, together with other recent contracts, will result in a continuous 5-mile section of 4-lane divided highway.

A project for improving this route from 4.4 miles east of Palmdale to the vicinity of Avenue T is presently under design, and the need for future widening and improvement to the San Bernardino County line is under study.

Foothill Freeway

The Foothill Freeway extends for 34.2 miles from junction with the Golden State Freeway to the San Bernardino County line near Claremont. In 1955 a 1.8-mile segment of this route in the Altadena-Flintridge area, was constructed to freeway standards at a cost of $2,098,000.

Urban development along a 10.5-mile section of this Interstate route, between the Golden State Freeway and Foothill Place near Hansen Dam, is introducing an increasing number of problems, and plans are being developed in sufficient detail to protect the right of way.

The California Highway Commission has adopted five freeway location units on the Foothill Freeway, as follows: Filbert Street to Foothill Place, 9.7 miles, March 26, 1958; Grand Avenue to San Bernardino County line, 6.8 miles, April 29, 1959; Michillinda Street to Bradbourne Avenue, 5.9 miles, May 20, 1959; Glendora Avenue to Grand Avenue, 4.7 miles, November 18, 1959; and Duarte city limits at Bradbourne Avenue to Glendora Avenue, 6 miles, February 17, 1960.

Aerial surveys covering the entire length of these five adoptions have been completed and design studies are presently under way.

On February 18, 1959, the Board of Directors of the City of Pasadena requested that the Division of Highways make a study of combining the Foothill Freeway with the Atchison, Topeka & Santa Fe Railroad between Marengo Avenue and a point east of Michillinda Avenue. This request was made upon a recommendation of the Pasadena Planning Commission after the second public meeting held by the Division of Highways on December 22, 1958 on that portion of the Foothill Freeway from Orange Grove Boulevard to Michillinda Avenue.

A report was prepared in cooperation with the staff of the City of Pasadena and presented to the Board of Directors on November 9, 1960,



Looking northerly along Golden State Freeway from East Los Angeles interchange; center, Santa Ana Freeway passing diagonally through photograph.



Looking northerly at construction in progress along Golden State Freeway; top, left, Elysian viaduct and interchange facilities with the Pasadena Freeway.

which indicated that the least expensive railway study would cost $19,000,000 more than the $43,000,000 as estimated for one of the most reasonable alternates outside of the influence of the Railroad. The City of Pasadena held a public meeting on January 10, 1961, and have indicated that they hope to reach a decision soon as to whether they will place a bond issue on the ballot or recommend that the State adopt one of the alternates outside of the influence of the Railroad.

The Advance Planning section also has under study a portion of the route from the Colorado Freeway to junction with Montana Street, which ties into a completed segment of the Foothill Freeway.

Garden Grove Freeway

The Garden Grove Freeway State Sign Route 22 extends from Pacific Coast Highway to the Newport Freeway, a distance of 15.4 miles.

In 1959 an interim project was completed to provide a 4-lane divided highway between Los Cerritos Channel and Knott Avenue, a distance of 5.4 miles, at a construction cost of $1,502,000. Most of this improvement will be utilized in the ultimate development of the freeway.

A contract for the construction of a reinforced concrete bridge and a frontage road between Studebaker Road and the proposed San Diego Freeway was awarded on September 21, 1960. This is a first-stage project in the development of the freeway. It is anticipated that this project will be completed late in 1961 at a cost of $271,000.

Plans are being prepared for the entire freeway based on 6 lanes except for a 2.1-mile, 10-lane section between Los Alamitos Boulevard and Bolsa Chica Road. In this vicinity the San Diego Freeway and the Garden Grove Freeway will utilize common roadways.

Contract plans are being prepared for a portion of the Garden Grove Freeway between Placentia Avenue and the Santa Ana Freeway, a distance of about 1 mile. Interchanges will be provided at Placentia Avenue and at Bristol Street. This project is Unit I of the Santa Ana, Orange, and Garden Grove Freeways interchange and will be financed from an item of $13,700,000 in the 1961-62 budget. It is anticipated that this construction will be ready to advertise for contract in mid-1961.

A portion of the Garden Grove Freeway from the Rio Hondo Channel to Pacific Coast Highway is under restudy in conjunction with the Pacific Coast Freeway through the City of Long Beach. It is anticipated that studies for this section of the Garden Grove Freeway will be presented at a public meeting sometime this year.



Looking easterly at completed portion of Glendale Freeway; foreground, bridges under construction connecting with interchange with Golden State Freeway.

Glendale Freeway

The Glendale Freeway State Sign Route 2 extends 3.2 miles from Ardmore to Vermont Avenues and from Glendale Boulevard to Avenue 36. A 1.1-mile section of this freeway, between Los Angeles River and Eagle Rock Boulevard, was completed in 1958 at a construction cost of $2,820,000. A landscaping contract was completed on January 8, 1960, between Fletcher Drive and Verdugo Road, at a cost of $94,000. Currently two contracts are under way on this freeway: one is between Riverside Drive and the Los Angeles River, including the interchange with the Golden State Freeway, 0.6 mile costing $830,000, awarded on April 12, 1960, with an estimated completion date of January, 1962 (part of a 3.7-mile, $12,404,200 contract on the Golden State Freeway between Arnold Street and Glendale Boulevard).

The outstanding feature of this project is the Glendale-Golden State Freeway Interchange, with its 12.7 miles of foundation piling, 6.5 acres of bridge deck, 3 miles of bridge railing and 94,500 tons of concrete. All of the



Looking northerly along recently completed portion of Harbor Freeway from 146th Street pedestrian overcrossing.

substructure work has been completed and falsework towering 50 feet above adjacent Riverside Drive is a marvelous sight to the passing motorist. The falsework is unique in that the bottom 20 feet is the typical heavy timber and steel beam type topped by tubular steel scaffolding to support the 12% superelevated deck.

A second Glendale Freeway contract, work on which started on November 4, 1960, after award on October 19, 1960, is in progress between Glendale Boulevard and Riverside Drive, 0.8 mile costing $2,325,800, tentatively scheduled for completion in January, 1962. Since the first order of work is the construction of realigned Allesandro Street and related city street work, there has been little work done on the freeway itself, except for the placing of some embankment material obtained in street excavation.

The moving of extensive utility facilities from old Allesandro Street to locations within the new roadway was begun recently. Much of this work was dependent upon the completion of rough grade by the contractor and side hill cuts and fills, which had to be made first. As the utilities are relocated, existing streets will be abandoned and work on the freeway started.

Sanitary sewer work was started within the first few weeks of construction and is nearly complete at this time. Some delay and slow progress was occasioned by encountering hard sandstone in trench excavation areas. In some instances it was necessary to use jack hammers to remove rock through which the trenching machine could not cut.

The unconstructed portion of the Glendale Freeway between Avenue 36 and the Foothill Freeway is actively under study. It is anticipated studies can be presented at a public meeting within the next two years.

Another segment west to junction with the Hollywood Freeway has been reactivated in connection with the study of the Beverly Hills Freeway. It is believed that this part of the Glendale Freeway study will be ready for a public meeting in the latter part of 1961.

Golden State Freeway

The Golden State Freeway (Routes 4 and 161), an Interstate highway, is 73.2 miles long in District VII, extending from junction with the Santa Ana, Santa Monica, and Pomona Freeways in East Los Angeles to the Kern County line north of Gorman.

The Golden State Freeway has been completed to largely expressway standards north of the City of San Fernando in San Fernando Valley via the Ridge Route to the Kern County line and has been opened to traffic for a number of years.

In the Burbank, Glendale and Los Angeles areas the Golden State Freeway is completed to full freeway standards and open to traffic between Burbank Boulevard and Glendale Boulevard. This 6-mile section was built previously under separate contracts: Ash Avenue to Los Angeles River, 2.2 miles, completed in September, 1957, at a construction cost of $4,753,000; Los Angeles River to Glendale Boulevard, 2.5 miles, completed in January, 1958, at a construction cost of $5,418,000; and Alameda Avenue to Burbank Boulevard, 1.3 miles, completed in August, 1959, at a construction cost of $4,240,000.

In the vicinity of downtown Los Angeles two important Golden State Freeway links were opened to traffic on March 18, 1960, between Sixth Street and Mission Road and between Mission Road and Pasadena Avenue, 2.5 miles, at a combined construction cost of $7,778,000.

At this time there are 6 projects in progress on the Golden State Freeway including the East Los Angeles Interchange, representing a mileage of 19.4 and a construction cost of $58,315,500.

Provision has been made in the 1961-62 fiscal year budget in the amount of $6,200,000 to complete the only remaining gap in the Golden State Freeway between Lankershim Boulevard and Osborne Street in the San Fernando Valley, a distance of 2.4 miles. Thus, taking into account completed and going projects and the

aforementioned budgeted project, the entire length of the Golden State Freeway represents an estimated grand total investment of $165,406,800 for both right of way and construction.

The active construction projects on the Golden State Freeway may be itemized as follows, in a generally south to north order: The *East Los Angeles Interchange*, bounded by 6th and 8th Streets and Boyle Avenue and Lorena Streets, 2 miles, $10,326,600; work started on May 1, 1959 and the estimated completion date is May, 1961. *Pasadena Avenue to Arnold Street*, including the interchange with the Pasadena Freeway, 1.7 miles, $10,410,000; work started on May 11 1960 and the estimated completion date is February, 1962. *Arnold Street to Glendale Boulevard*, including the Glendale Freeway Interchange, 3 miles, $12,404,200; work started on April 20, 1960 and the estimated completion date is April, 1962. *Burbank Boulevard to Roscoe Boulevard*, 4 miles, $8,830,400; work started on March 5, 1959 and the estimated completion date is June, 1961. *Roscoe Boulevard to Lankershim Boulevard*, 2 miles, $3,718,500; work started on December 1, 1959 and the estimated completion date is June, 1961. *Osborne Street to San Fernando Road* (including grading on 4 miles the San Diego Freeway as far south as Nordhoff Street), 6 miles, $12,625,800; work started in February, 1961 and the estimated completion date is July, 1963.

Design is under way for relocation of expressway portions of the Golden State Freeway from junction with the San Diego Freeway at the San Fernando Reservoir north to the Kern County line. It is hoped that by the spring of 1961 relocation studies will be sufficiently developed for discussion at a public meeting.

Among the minor contracts completed and in progress on the Golden State Freeway is a landscaping project between Mission Road and North Broadway, 0.9 mile covering 9 acres, under a $52,800 contract scheduled for completion in July, 1961. Another landscaping project was completed between Linden Avenue and Cypress Avenue, 1.3 miles covering 15 acres, on October 31, 1960 at a cost of $92,500. The 1961-62 budget has additional allocations amounting to $290,000 for continued landscaping on 5.2 miles of freeway between Cypress Avenue and Roscoe Boulevard and between Roscoe and Lankershim Boulevards. A median barrier will also be installed on the Glendale Boulevard to Burbank Boulevard section, a distance of 6.1 miles, for which $143,000 is available in the new budget.

(For a complete discussion of the Golden State Freeway and the loop portion of the Santa Monica Freeway, see story, *LOOP PROGRESS*, by A. L. Himelhoch, District Engineer, in the January-February issue of *California Highways and Public Works.)*

Harbor Freewoy

The Harbor Freeway begins at the 4-level structure in the Los Angeles Civic Center and proceeds 22.6 miles south to Battery Street in San Pedro. The entire route is largely completed and in use, except for two contracts under construction between 190th Street and 208th Street and between 208th Street and Pacific Coast Highway, and interchange structures at the Santa Monica Freeway interchange. The total moneys expended or committed on going, completed and budgeted projects on the Harbor Freeway amount to approximately $102,692,000.

A 4.7-mile length of the Harbor Freeway was completed in August, 1960. This $7,755,000 contract extended the 8-lane Harbor Freeway from 124th Street to 0.5 mile south of 190th Street. It provides connection facilities with such important east-west arteries as El Segundo Boulevard, Rosecrans Boulevard, Alondra Boulevard, Artesia Boulevard, and 190th Street. Included in this length of the Harbor Freeway are 17 bridges, a pumping plant and 10 retaining walls. The contract started in October, 1958 and was accepted by the Director of Public Works on August 5, 1960, in advance of the originally scheduled completion date. In the Dominguez Channel and 190th Street area, some 143,000 cubic yards of an old trash dump had to be removed.

This contract on the Harbor Freeway also initiated slip-form paving in Southern California. Using a 24-foot wide slip-form machine the contractor placed 61,800 cubic yards of concrete pavement and was successful in meeting the smoothness requirements. (See articles on slip-form paving in the January-February and May-June, 1960 issues of *California Highways and Public Works).*

Two contracts on the Harbor Freeway are being constructed as a part of



Branch connections of East Los Angeles interchange looking northeasterly.

other projects. These are the Harbor-Santa Monica Freeway interchange, being built at a cost of $320,000 in conjunction with a larger Santa Monica Freeway contract, and the Harbor-San Diego Freeway interchange, being built at a cost of $780,000 in conjunction with a larger San Diego Freeway contract.

A major project under construction on the Harbor Freeway proper is in progress from 208th Street to Pacific Coast Highway, a distance of 4.7 miles. It specifies 6- and 8-lane freeway, with bridge widening at Pacific Coast Highway, 2 pedestrian overcrossings and 10 bridge structures. Work started on December 22, 1960. Under way now is the placing of reinforced concrete box structures and large drainage pipes, along with bridge, pedestrian overcrossing and retaining wall work. Target date for the completion of this section of the Harbor Freeway is May, 1962.

Certain minor projects have been completed in 1960 on the Harbor Freeway, among them a landscaping job from Athens Boulevard to 88th Place, 2.5 miles, April 4, $178,000; September 26, $142,000; and median barrier from 120th Street to 190th Street, 4.4 miles, November 1, $75,000.

On March 9, 1961 bids were opened for landscaping of 4.4 miles of the Harbor Freeway between 120th and 190th Streets. This job is now in progress. A lighting and signing job from 6th Street to the 4-level structure was awarded on January 31, 1961, at a bid figure of $68,900 from 1960-61 funds, and is tentatively scheduled for completion in May, 1961.

The 1961-62 budget allocated $645,000 for median barrier on the Harbor Freeway from 120th Street to the 4-level structure (including a portion of the Santa Ana Freeway), a total distance of 15.7 miles. Construction should begin on this project sometime in the summer of 1961.



Long Beach-San Bernardino Freeway interchange looking westerly.

Hollywood Freeway

An important section of the Hollywood Freeway (Routes 2 and 159) has been completed and open to traffic for a number of years, from Spring Street in the Los Angeles Civic Center to the Ventura Freeway interchange in North Hollywood, a distance of about 11 miles. Its extension north to junction with the Golden State Freeway near Wentworth Street will ultimately measure 17.3 miles in all. The first contract on the Hollywood Freeway was completed in the Cahuenga Pass area in 1940 and the last major contract, a widening project between Highland Avenue and Lankershim Boulevard, was completed in 1958.

The importance of this route as a vital connector between Los Angeles and the San Fernando Valley is evidenced by the universal acceptance it has gained from the traveling public. Westerly of the 4-level structure 200,000 motor vehicles use this freeway daily.

The total cost of the Hollywood Freeway, including projects completed and minor contracts under way, is $68,971,000 for right of way and construction.

On March 9, 1961 bids were opened on the Hollywood Freeway Extension between Vineland Avenue and Chandler Boulevard, 1.7-miles, from $3,000,000 available in the 1960-61 budget. This project provides for such structures as the Tujunga Avenue Undercrossing, Magnolia Boulevard Undercrossing and pedestrian undercrossings at Morrison and Otsego Streets.

Northerly of present construction at Chandler Boulevard the Hollywood Freeway is under design to its terminus at the Golden State Freeway.

One of the first median barrier installations was on the Hollywood Freeway on portions as far west of the Civic Center as Benton Way (including some mileage on the Santa Ana Freeway), completed on May 11, 1960 at a cost of $143,000. During the same year a $68,000 landscaping contract was completed between Moorpark and Kling Streets. The 1961-62 budget, as supplemented in January, 1961 by the California Highway Commission, has a $418,000 allocation for 6.3 miles of additional median barrier from Benton Way to the Ventura Freeway interchange.

Imperial-Yorba Linda Freeway

The Imperial Freeway (Route 176) is now part of the California freeway-expressway network as signed into law under Senate Bill 480, by Governor Edmund G. Brown on June 19, 1959, which added six miles to the route from La Habra Road (State

Sign Route 39) in Orange County to the Santa Ana Freeway near Norwalk in Los Angeles County. From La Habra Road southeasterly to the Riverside Freeway beyond Yorba Linda the route is known locally as the Yorba Linda Freeway. It is on the existing freeway-expressway system.

General plans for construction of two lanes of an ultimate 2.3 mile, 4-lane freeway from Yorba Linda Boulevard to the Riverside Freeway were discussed at a public meeting held by the District on February 23, 1961. Initial construction on the Yorba Linda Freeway is financed to the extent of $1,360,000 in the 1961-62 fiscal year.

Laguna Freeway

The Laguna Freeway (Route 185) extends 8.4 miles from the City of Laguna Beach to the Santa Ana Freeway.

In 1958 the northerly two miles were improved to expressway standards in conjunction with construction on the Santa Ana Freeway. In this improvement two lanes of the proposed 4-lane freeway were constructed.

Preliminary design studies are now under way for the remainder of this freeway. At its southerly end near Canyon Acres Drive the freeway will connect to an existing expressway.

Long Beach Freeway

The Long Beach Freeway (State Sign Route 15) from Pacific Coast Highway in Long Beach to Huntington Drive in Los Angeles, is 21.5 miles long. It was officially opened between Pacific Coast Highway and the Santa Ana Freeway on July 10, 1958 and today represents an accumulated investment in going and completed projects of $55,946,000 for both right of way and construction. The completed traversable section is 16.8 miles long and temporarily terminates at the Santa Ana Freeway, from which point it is under construction as far north as the San Bernardino Freeway.

The Long Beach Freeway extension northerly from the Santa Ana Freeway to the San Bernardino Freeway is scheduled for completion in May. Work began in February, 1959 with a contract allotment of $6,651,500.

Construction of a reinforced concrete box storm drain and appurtenant drainage structures for the Los Angeles County Flood Control District has been completed. The storm drain extends 1.6 miles and ranges in dimensions from 9½ x 9½ feet to 13½ x 10½ feet. Also completed, is the construction of sanitary sewers, including a main for the City of Monterey Park.

Work on the east connector overcrossing at the San Bernardino Freeway Interchange is rapidly nearing completion, this being the last of 13 structures to be built on this contract.

Upon its completion in the spring of 1961, this new link of the Long Beach Freeway will serve to reduce congestion in the metropolitan Los Angeles area by providing a more direct route between the San Gabriel Valley communities and the cities located between Los Angeles and Long Beach.

A functional planting project was awarded on November 29, 1960 covering 7.2 miles and almost 86 acres of the Long Beach Freeway between Pacific Coast Highway in Long Beach and East 26th Street near Vernon. The bid figure on this job is $74,000 and landscaping will be completed in the summer of 1961.

Senate Bill 480 established a 1.7-mile extension of the Long Beach Freeway from the City of Alhambra to near junction of the Foothill-Pasadena Freeways. In conjunction with the north-south leg of the Foothill Freeway through the City of Pasadena, the Advance Planning section has under study that portion of the Long Beach Freeway extension between Norwich Avenue and the Colorado-Foothill Freeway.

The City of Long Beach has been a unique and substantial contributor to the development of the Long Beach Freeway in the Long Beach area. Utilizing the 5/8-cent gas tax revenues, general public funds, tideland oil and harbor funds, the City of Long Beach has financed construction of several projects in connection with the Long Beach Freeway.

The continuation of the freeway south into the Long Beach Harbor area on the west side of the river is planned by the City for the near future and $1,226,500 has already been expended for rights of way. The Ocean Boulevard bridge provides overpass structures for the freeway, including future connections for on and off ramps. It also provides for separation of grade for terminus extension at Ocean Boulevard connections. This bridge, built at a cost of $7,715,000, was completed and opened to traffic in August, 1959. It connects the central business district with the harbor area.

Marina Freeway

The Marina Freeway (Route 60 and 221) between Pacific Coast Highway and Sepulveda Boulevard in the Culver City-West Los Angeles area, 3.9 miles, was adopted by the California Highway Commission in December, 1959. Preliminary design has been expedited so as to cooperate with the U.S. Corps of Engineers in its program for construction of the Centinela Creek Flood Control Channel, which is scheduled to start in the spring of 1961. The Centinela Creek Channel, between Jefferson Boulevard and McConnell Street, a distance of 1.5 miles, is immediately adjacent to the Marina Freeway. Alignment of the common boundary has been agreed upon.

The Los Angeles County Flood Control District is responsible for acquisition of rights of way for U.S. Flood Control projects. The Flood Control District and the State have entered into a cooperative agreement whereby the State is acquiring those parcels, portions of which will be needed for both the Flood Control project and the freeway.

Newport Freeway

The Newport Freeway (State Sign Route 55) extends 17.7 miles from the Riverside Freeway to Pacific Coast Highway in Orange County. The route was adopted by the Highway Commission on July 20, 1944, from Pacific Coast Highway to Dyer Road, and on March 17, 1954, from Dyer Road to the Riverside Freeway.

A 1.9-mile expressway portion of the Newport Freeway was built from Pacific Coast Highway to 20th Street in Costa Mesa in 1953. Also, a 2.7-mile project was completed on May 31, 1960, which constructed a front-

age road between 19th Street and Palisades Road in and near Costa Mesa. This frontage road will eventually adjoin the proposed 6-lane freeway, but currently is used for south-bound traffic to provide a 4-lane divided highway.

A 4.2-mile project from Chapman Avenue to the Riverside Freeway has been under construction since January 10, 1961, after award of contract on December 22, 1960. The estimated completion date of this $4,638,029 contract is February, 1962. Bids for a second project from Chapman Avenue south to connection with the Santa Ana Freeway were opened on March 16, 1961 from approximately $4,500,000 available in the 1960-61 fiscal year. Construction on this link is now in progress.

Contract plans are currently being prepared for a 5.4-mile section of the Newport Freeway from the Santa Ana Freeway south to Palisades Road. This construction awaits future financing.

Ojai Freeway

The Ojai Freeway (U. S. 399) extends 6 miles from Pacific Coast Highway in the City of Ventura to Foster Park in Ventura County. A small segment of the Ojai Freeway from the Pacific Coast Highway to Prospect Street is under construction in conjunction with a $6,506,432 contract on the Ventura Freeway.

The District held a public meeting on September 1, 1960 relative to route location studies for the Ojai Freeway from Foster Park north to Gorham Road east of the City of Ojai, ranged between $10,000,000 and $14,000,000 for construction, and between $2,000,000 and $7,500,000 for rights of way.

At the request of the City of Ojai and the County of Ventura, the information regarding Ojai Freeway studies was deferred for a period of six months before submission to the California Highway Commission. A report has been returned by the special committee appointed by the County and the City of Ojai Council requesting that a freeway route be adopted alongside the Ventura River to its junction with Maricopa Highway northwest of Ojai. The District has this proposal under advisement.



Looking south along Santa Ana Freeway at Long Beach Freeway interchange. White areas indicate added lanes on Santa Ana Freeway.



San Bernardino Freeway looking easterly at El Monte and the Baldwin Avenue interchange. The white areas in median are the newly constructed concrete pavement widening.



Looking north along relocated Lakewood Boulevard at Long Beach Municipal Airport. Construction in foreground is San Diego Freeway.

Orange Freeway

The Orange Freeway (Route 19) has been adopted (1956) for a distance of 16.6 miles from the Santa Ana Freeway near Orange in Orange County to the Pomona Freeway in Los Angeles County. Provision for interchange facilities for the Orange Freeway with the Garden Grove and Santa Ana Freeways is included in a $7,000,000 construction project in the 1961-62 budget, which is scheduled for bid advertising late in 1961.

Plan preparation is under way for the remainder of this freeway and construction will be financed when funds are available. Expenditures totaling $1,816,000 on the Orange Freeway, to date, have been exclusively for right of way.

Pacific Coast Freeway

The Pacific Coast Freeway (U.S. 101 Alternate) is an adopted route from the City of Oxnard in Ventura County to the Los Angeles County line near Mulholland Highway, a distance of 18.1 miles.

Of this mileage 7.2 miles between the City of Oxnard and Calleguas Creek was completed to full freeway standards on November 15, 1957, at a cost of $2,413,000. A recent addition has been in the form of a short segment, 0.7-mile, completed on December 1, 1960 between the San Diego Freeway and Serra Junction near San Juan Capistrano in Orange County. This $117,000 connection was built together with a major San Diego Freeway contract between Capistrano Beach and San Clemente. Another 4.5-mile link in the Pacific Coast Freeway was adopted (1955) in Orange County, between Huntington Beach and Newport Beach.

The District expects to hold a public meeting on that portion of the Pacific Coast Freeway between the present junction of Pacific Coast Freeway with 5th Street (Route 153) and the Ventura Freeway in the spring. This is the so-called "Oxnard Bypass."

A little later, the District expects to proceed with a public meeting on that portion of the Pacific Coast Freeway between Calleguas Creek and Malibu Beach. Studies are also underway between Malibu Creek and the City of Santa Monica.

In cooperation with the State Department of Natural Resources, the State Division of Beaches and Parks and the State Division of Small Craft Harbors, an attempt is being made to develop a cooperative plan for recreational and highway purposes. The Department of Water Resources has requested a study by the U. S. Corps of Engineers of the beach erosion problems in this area.

Also under study is that area between the Santa Monica Freeway and the Marina Freeway. It is anticipated that a public meeting on this route will be held shortly.

In conjunction with the studies in the Los Angeles International Airport area, that portion of the Pacific Coast Freeway between the Marina Freeway and Imperial Highway is being investigated in order to provide good vehicular circulation in connection with the expansion of the airport.

In conjunction with the studies on the Garden Grove Freeway, the Advance Planning section is actively engaged in the replacement of the existing Pacific Coast Highway as a freeway between the Garden Grove Freeway and the Harbor Freeway in the vicinity of the City of Long Beach and the communities of Wilmington and San Pedro.

Also under active planning is that portion of the Pacific Coast Freeway from its junction at the San Gabriel River Freeway Extension to the San Diego Freeway near San Clemente.

Project report studies have been completed for conversion of the existing 3-lane and 4-lane Pacific Coast Highway to an ultimate 8-lane freeway for 22.3 miles between Malibu and Point Mugu. Studies have considered improvement along the existing route, which is generally adjacent to the Pacific Ocean as well as improvement on a new location inland, wherever feasible. A public meeting will be held soon to discuss this $35,000,000 improvement.

A 4.5-mile length of the existing Pacific Coast Highway between Beach Boulevard in Huntington Beach and Newport Avenue (Route 43) in Newport Beach was adopted by the California Highway Commission as a portion of Pacific Coast Freeway in 1955.

Preliminary design studies are now in progress and right of way negotiations are under way for the portion between Beach Boulevard and the

Santa Ana River. Plans are based on an ultimate 8-lane freeway.

Pasadena Freeway

The Pasadena Freeway is 8.2 miles long, extending from the 4-level structure in downtown Los Angeles to Glenarm Street in the City of Pasadena. The first unit, a 6-lane freeway, was completed and opened to traffic on December 30, 1940. The last unit of construction on this freeway was completed and opened to traffic on September 22, 1953. The total investment in rights of way and construction on the Pasadena Freeway to date, including going contracts, amounts to $12,218,000.

On December 29, 1960 at 10:00 a.m., the Division of Highways joined with commemoration sponsors in 20th anniversary ceremonies marking the completion of the Arroyo Seco-Pasadena Freeway.

A project is under way on the Pasadena Freeway between Bishops Road and Avenue 40 in conjunction with the Pasadena-Golden State Freeway interchange. This $410,000 job is scheduled for completion with the larger Golden State Freeway project between Pasadena Avenue and Arnold Street in January, 1962. Also under contract over portions of the route, is median barrier construction. Bids on this project were opened on March 16, 1961 from $365,000 available in 1960-61 State Highway funds. The 1960-61 budget also has $200,000 available for improved lighting of 4 existing tunnels located between Bishops Road and the Los Angeles River on the Pasadena Freeway. Bids will be opened April 13 for this work.

Design is in progress on improvement of access facilities to the Elysian Park area. The new $16,000,000 Dodger Stadium scheduled for completion in 1962 in Chavez Ravine, the proposed World Zoo, new playground and recreational facilities, will generate traffic volumes greater than existing ramps can handle. A cooperative agreement with the City of Los Angeles is being processed to cover the cost of these improvements. (For a history of the Pasadena Freeway see A. D. Griffin's article ARROYO SECO in the January-February 1961



Looking north along completed San Diego Fwy. toward Dana Point, top, left. In foreground is connection at Serra Junction to existing Pacific Coast Highway.



Looking north along newly completed portion of San Diego Freeway in San Clemente.



Looking westerly along Santa Monica Freeway construction from Santa Fe Avenue near Los Angeles River.

issue of *California Highways and Public Works.)*

Pamona Freeway

The adopted portion of the Pomona Freeway extends easterly from the East Los Angeles Interchange, now under construction, to a junction with the Corona Freeway at the southerly limits of the City of Pomona for a total length of 30.6 miles. It will cost an estimated $58,500,000 for construction, including rights of way.

When completed, this section of the Pomona Freeway, in conjunction with the Santa Monica Freeway, will provide a major east-west route from the Pacific Coast Highway, through the metropolitan Los Angeles area, to Pomona. It will greatly relieve high density traffic pressures on the present operating east-west routes in the District.

Adoption of the aforementioned sections of the Pomona Freeway was completed by the California Highway Commission on June 23, 1960 with the adoption of the easterly section from the junction of the Pomona Freeway and Brea Canyon Road (Route 19) to the Corona Freeway.

This 1961-62 State Highway Budget contains $8,800,000 for continued right of way acquisition on the Pomona Freeway.

Riverside Freeway

The District VII portion of Riverside Freeway is 19.1 miles long, extending from the Santa Ana Freeway near Buena Park to the Riverside County line in Orange County.

Completed in January, 1960 was the 2.2-mile freeway section between Spadra Road and Placentia Avenue at a cost of $2,680,000. A landscaping project costing $82,000 between Magnolia Avenue and Lemon Street, 3.3 miles, was completed in November, 1960.

The westerly 5.7 miles are now constructed to full freeway standards and the remainder to expressway standards. Plans are being developed for the conversion of 4.1 miles of 4-lane expressway between Cypress Street and the Newport Freeway to a 6-lane freeway.

Plans are being completed for a landscaping project on the Riverside Freeway, 2.1 miles, between Lemon Street and Placentia Avenue. Funds in the amount of $64,000 are provided in the 1961-62 budget.

The total construction and right of way costs on the Riverside Freeway amount to $15,844,000 to date.

The District held a public meeting on December 1, 1960 on the routing of a portion of the Riverside Freeway from its junction at Santa Ana Canyon to the Riverside County line, and presented the facts on this meeting to the California Highway Commission in February.

San Bernardina Freeway

The District VII portion of San Bernardino Freeway extends 30.6 miles from the Santa Ana Freeway near Los Angeles River to the San Bernardino County line in Claremont and is completed throughout. Projects under contract and those previously

completed represent a total expenditure of $60,785,000 to date. A series of widening jobs will increase the carrying capacity of this important east-west route by adding a lane inbound and outbound, giving increased traffic service on 6 and 8-lane sections.

Widening work started on the most westerly section of the San Bernardino Freeway between Eastern Avenue and Rosemead Boulevard on July 11, 1960, under $1,920,100 contract. Work to date on the 5.4-mile job has consisted primarily of widening or altering 17 bridges on the project.

Reconstruction design and construction methods and procedures permitted the continuous use of the San Bernardino Freeway and the overcrossings with the exception of the Almansor Avenue overcrossing which was closed to vehicular traffic for a period of three weeks.

The original pedestrian overcrossings consisted of welded steel girder superstructures continuous over reinforced concrete piers with the center spans hinged. Two of the original piers at each structure were located in areas of the new freeway lanes.

Reconstruction consisted of constructing 4 reinforced concrete piers (only 3 new piers were required at the Campbell Avenue pedestrian overcrossing) adjacent to the freeway shoulders. Bearing stiffeners were installed at new pier locations and tiedowns constructed as required. The superstructure was jacked up 1½ inches uniformly at the old piers to permit installation of the bearing assemblies at the new piers. The structure was then lowered onto the old piers. The new bearing assemblies were raised to full bearing and grout pads placed. The superstructure was again jacked up at the old piers to permit removal of the old bearing assemblies. The superstructure was then lowered onto the new piers and the old piers were removed.

The Almansor Avenue overcrossing consisted of 3 welded steel girder spans with a reinforced concrete deck slab simply supported on reinforced concrete abutments and bents. These bents were located in areas of the new freeway lanes.

Reconstruction consisted of constructing 4 steel bents on concrete pile footings adjacent to the freeway shoulders. Hinge assemblies connecting the girders were installed over the old bents where the structure was simply supported originally. Stiffeners were installed and abutment tiedowns constructed. The superstructure was jacked up ¼-inch uniformly at the old bents and the new bents raised to full bearing by adjusting anchor bolts at the bottom of the bents. Grout pads were placed under the bent grillage systems and the old bearing assemblies removed. The superstructure was then lowered onto the new bents and the old bents were removed.

Cost of reconstructing the three pedestrian overcrossings was approximately $37,500, an average of $12,500 for each structure. The Almansor Avenue overcrossing was reconstructed at a cost of $44,000. These costs include cleaning and painting the original structural steel.

Bids for a second widening contract between Rosemead Boulevard and Puente Avenue were opened on April 28, 1960. The low bid was $1,-148,488 covering a distance of 6.5 miles.

The work on this contract consisted of addition of two 12-foot lanes in the existing median area, with 8-foot median shoulders. For the portion between Rio Hondo Bridge and Puente Avenue, a distance of approximately 5 miles, a chain link median barrier was installed.

To provide for this additional lane, 11 bridges had to be widened, a 550-foot cantilever retaining wall had to be constructed, and revisions made to the median drainage system.



Looking westerly along Santa Monica Freeway (from Los Angeles River) at construction in progress; foreground, part of East Los Angeles interchange.

One of the major segments of work under the contract was the revision of the existing freeway signing to conform to Federal Interstate standards. Approximately 20% of the bid quantity was concerned with signing items.

While this contract could be considered a routine widening contract it was noted that the existing concrete pavement had a longitudinal keyway which locked it to the new slab. Since traffic was running on the existing pavement immediately adjacent to this new slab, it was believed that random cracking in the new lane would be a serious problem. Adding further emphasis to the possibility of random cracking was the fact that at least 90% of the existing joints were working joints. For a solution to this problem the use of a formed weakened plane joint was decided upon.

The use of masonite strips conforming to the requirements of the 1954 Standard Specifications, in lieu of sawing the transverse joints, proved very satisfactory as no random cracks have developed.

The most easterly widening job on the San Bernardino Freeway, between San Dimas Avenue and the San Bernardino County line, 5.7 miles, was completed on December 21, 1960 at a construction cost of $970,000. Other projects completed on this freeway during 1960 include realignment between Macy and Fickett Streets (built together with the interchange with the Golden State Freeway), 1.1 miles at a cost of $3,044,000 on March 30; the Hoyt Avenue off-ramp in El Monte at a cost of $145,000 on April 18; landscaping between Westcott Avenue and West Covina, 2.3 miles covering 23.3 acres, on November 30.

An undercrossing on the San Bernardino Freeway in the Covina area is in progress at Grand Avenue, at a contract price of $664,000 with an estimated completion date of February, 1962. This contract includes construction of Grand Avenue, Federal Aid Secondary Route 860, between Rowland Avenue and Toni Drive, and is being financed jointly by the State and the County of Los Angeles.

Studies covering widening of the freeway from 6 to 8 lanes between the Golden State Freeway and the Long Beach Freeway, are nearing completion. Also, plans are presently being prepared for widening to 8 lanes between Holt Avenue and San Dimas Avenue. This is the Kellogg Hill portion of the San Bernardino Freeway.

The 1961-62 budget contains $115,000 for median barrier construction for 2 miles of freeway between Evergreen Avenue in Los Angeles to just east of the Long Beach Freeway in Monterey Park; and $310,000 for median barrier construction for 9.5 miles of freeway between Arroyo Avenue in West Covina to Puente Avenue in Baldwin Park (this will connect with median barrier installation under widening contract west of Puente Avenue).

Landscaping plans for 1961 call for planting at the Orange Avenue and Pacific Avenue, and Sunset Avenue and Irwindale Avenue interchanges in West Covina ($65,000 in the 1961-62 budget) and Long Beach Freeway to Westcott Avenue in Baldwin Park ($375,000 in the 1961-62 budget).

San Diego Freeway

In District VII the San Diego Freeway extends from the San Diego County line near San Clemente to the Golden State Freeway near the San Fernando Reservoir, a total length of 94.5 miles. Portions of this Interstate route are constructed, under construction or budgeted for construction and on other sections of the route right of way is being acquired and freeway design is in progress. As of December 31, 1960, $173,566,000 had been committed for right of way and construction on going and completed projects on the San Diego Freeway.

This freeway was completed and opened to traffic from Burbank Boulevard to Valley Vista Street in San Fernando Valley (along with a portion of the Ventura Freeway), a distance of 1.2 miles, on July 3, 1958, at a construction cost of $2,800,000; Mulholland Drive was relocated and a bridge built across the future San Diego Freeway in the Santa Monica Mountains on April 1, 1960 at a cost of $1,824,000; on the West Los Angeles side of the Santa Monica Mountains, 2 miles were added between Casiano Road and Ohio Avenue in 1957 at a cost of $4,641,000; on February 19, 1959, 3.5 miles were added between Ohio Avenue and Venice Boulevard at a cost of $6,440,000, and on July 14, 1960 a 1.8-mile section was completed from Venice Boulevard to Jefferson Boulevard at a construction cost of $5,371,000.

Additional mileage on the San Diego Freeway has been constructed in Orange County since early 1958, when the first unit of 1.6 miles was completed at a cost of $665,000 from a junction with the Santa Ana Freeway near El Toro Marine Corps Air Station to Niguel Road. On September 22, 1959, a 7.5-mile section costing $4,218,000 was completed from Niguel Road to Trabuco Creek, where it joins another 3.7-mile section through San Juan Capistrano completed on December 24, 1958, under $4,081,000 contract. Another San Diego Freeway project through San Clemente to the San Diego County line, 1.8 miles, was completed on October 20, 1958, at a cost of $2,413,000. On December 1, 1960 a connecting link was completed between San Juan Capistrano and San Clemente, adding 5.8 miles of freeway at a construction cost of $6,358,000.

Some of the minor San Diego Freeway projects completed during 1960 are as follows: landscaping, Burbank Boulevard to Ventura Boulevard, April 26, $95,000; landscaping, Wilshire Boulevard to Matteson Avenue, April 28, $164,000; and bridge and approaches, Willow Street to Lakewood Boulevard, March 14, $154,000.

Bids were opened on January 5, 1961 on a grading only project for the San Diego Freeway from junction with the Golden State Freeway in the north San Fernando Valley to Nordhoff Street, a distance of about 4 miles. This project is part of a $12,625,800 contract on the Golden State Freeway scheduled for completion in March, 1963. A future contract will be let for structures and paving.

An adjoining contract in the amount of $17,224,700 was awarded on July 25, 1960, for a distance of almost 12 miles, between Nordhoff Street and Casiano Road in West Los Angeles, with grading only for that portion of the freeway between Nordhoff Street and Burbank Boulevard (6.2 miles).

Construction to full freeway standards of the 5.6-mile link through the Santa Monica Mountains will close the gap between Casiano Road, the present terminus of the San Diego Freeway, and Valley Vista Street in the San Fernando Valley.

The portion between Casiano Road and Mulholland Drive is located in the same narrow pass containing existing Sepulveda Boulevard. In order to avoid interference with traffic using Sepulveda Boulevard, stage work was included in the contract. Construction will get into full swing this summer, after completion of stage work. The estimated completion date for the entire contract is late 1962.

Next construction on the San Diego Freeway is at Manchester Boulevard in the Inglewood area, where 3 bridge structures were completed on January 31, 1961 at a construction cost of $421,400. On December 28, 1960 a $1,633,000 contract was awarded for construction of roadways, bridge approaches and 5 bridges between Manchester Boulevard and Vesta Street, a distance of 0.5-mile. This project is tentatively set for completion in April, 1962. On March 9, 1961 bids were opened on a San Diego Freeway project in the Lawndale-Torrance area, between Hawthorne Boulevard (Route 164) and 174th Street, a distance of 1.2 miles, for which $3,400,000 in 1961-62 State Highway funds was provided.

A project from the 174th Street to 190th Street was awarded on December 23, 1960 for the low bid of $6,668,846. The estimated completion date of this 3.4-mile segment is summer of 1962.

Work started on July 17, 1960 on the San Diego Freeway (and a segment of the Harbor Freeway between 190th Street and 208th Street) between 190th Street and Carson Street, a distance of approximately 3 miles, under an $8,120,000 contract. Plans call for 17 bridges on this job. May, 1962 is the target date for completion of this project.

A connecting job is that from Carson Street to Alameda Street, 1.9 miles, awarded in the sum of $4,321,900 on December 13, 1960. The estimated completion date of this freeway unit, which will have 3 bridges, is



Looking north along the San Diego Freeway construction area. Existing horseshoe curve on Sepulveda Boulevard, center, and relocated Mulholland Drive and bridge, foreground.

June, 1962. Storm drain construction and imported borrow operations are now in progress.

From Alameda Street to the Long Beach Freeway another construction contract is in progress for a distance of 1.3 miles. The $5,134,400 contract was awarded on April 20, 1960. Completion is anticipated by December, 1961. The project will have 10 major structures and provide the interchange between the San Diego Freeway and the Long Beach Freeway. Major construction items include 2,300,000 tons of imported borrow, 16,000 cubic yards of structure concrete, 74 precast, prestressed concrete girders and 101 precast, prestressed deck units.

Work started December 8, 1960 on a project between Lakewood Boulevard and Cherry Avenue in Long Beach and Signal Hill. The $1,350,400, 0.7-mile job is tentatively scheduled for January, 1962 completion and consists of the construction of the Spring Street overcrossing bridge and approaches, retaining wall, pumping plant, storm drains and sanitary sewer relocation work and will provide for moving roadway excavation material through the cities of Long Beach and Signal Hill at separated grade in future roadway contracts. A recent allocation by the California Highway Commission adds another $3,700,000 to the 1961-62 budget for separation structures and approaches east ro Studebaker Road.

Bids were opened on March 23, 1961 on a landscaping contract on the San Diego Freeway between Venice and Jefferson Boulevards in West

Los Angeles and Culver City. The 1.8-mile section was financed by $150,000 from funds available in the 1960-61 State Highway budget.

The Highway Commission in October, 1960 made heavy allocations of State Highway funds on San Diego Freeway jobs in the 1961-62 fiscal year in District VII. The financed jobs are as follows: from Jefferson Boulevard to 174th Street, 10 miles, $24,600,000 (bids were opened on March 9, 1961 on a project at the southern end); from the Long Beach Freeway near Long Beach to California Avenue in Signal Hill, 1.8 miles, $8,000,000; median barrier, Casiano Road to Jefferson Boulevard, 7.2 miles, $190,000; landscaping, Avenida Allessandro in San Clemente to near U. S. 101 Alternate, 7.1 miles, $152,000; and truck scales, 4.3 miles south of Niguel Road near El Toro, $210,000.

Plans for the section of the San Diego Freeway between 174th Street and Jefferson Boulevard have been completed. It is anticipated that it will be advertised by the spring of this year. Combined, this work and those adjacent projects already under contract will provide the longest continuous stretch of 8-lane freeway under construction at one time in the District's history.

San Gabriel River Freeway

Construction plans are now in preparation for the entire 22.6 miles of the San Gabriel River Freeway extending from the Garden Grove Freeway in Orange County to the San Bernardino Freeway in Los Angeles County. Interchange facilities will be provided between this freeway and the San Diego, Santa Ana, Garden Grove, Artesia, Pomona and San Bernardino Freeways as well as with major county roads and city streets.

This freeway passes through portions of the cities of Dairy Valley, Norwalk, Santa Fe Springs, Downey, Industry, Baldwin Park and Long Beach. Freeway agreements have been executed by all of these cities and also by Los Angeles County. Right of way acquisition is in progress throughout the entire length, with an additional $10,000,000 allocation for fiscal 1961-62. Right of way monies already expended on the San Gabriel River Freeway (as of December 31, 1960) amount to $16,867,000.

The 1961-62 construction budget includes an item of $800,000 for construction of an interim project on the existing route which will include construction of the Peck Road overcrossing and the Peck Road interchange on the San Gabriel River Freeway. It is anticipated that this project will be under construction by September, 1961.

Santa Ana Freeway

The Santa Ana Freeway extends 43 miles from Spring Street in downtown Los Angeles to a junction with the San Diego Freeway near El Toro in Orange County. The first construction contract on the Santa Ana Freeway was completed in February, 1947, on a 1.5-mile section between Kearney and Soto Streets, at a cost of $1,495,000. This freeway is open to traffic throughout and has been in service for a number of years. In right of way and construction, including going contracts, the Santa Ana Freeway has cost $74,308,000 up to December 31, 1960.

Minor projects completed on the Santa Ana Freeway in 1960 include construction of median barrier between Benton Way (Hollywood Freeway) and Lakewood Boulevard, May 11, $200,000; ramp revision and lighting at Telegraph Road and Slauson Avenue, August 5, $18,000; and a pedestrian ramp at Florence Avenue, February 1, $15,000.

A contract for widening the Santa Ana Freeway from six lanes to eight lanes, 0.7-mile, between the Long Beach Freeway and Atlantic Boulevard was awarded on June 20, 1960, and completed on February 21, 1961 at a cost of $485,000. The additional width will provide increased merging distance for traffic to and from the Long Beach Freeway.

Current contracts include a $172,500 landscaping project between Orangethorpe Avenue, 2.3 miles covering 23 Ana, 5.5 miles covering 23 acres, scheduled for completion in July, 1961; and a $99,100 landscaping project between Coyote Creek and Orangethorpe Avenue, 2.3 miles covering 23 acres, scheduled for completion in July, 1961.

Studies are in progress for widening this freeway to a 6-lane facility from the Laguna Freeway to Santiago Creek, a distance of some 10.2 miles. Plans are being completed for the necessary construction to convert the 4-lane freeway to 6-lane width for 3.8 miles between South Street and the Santa Ana River. This project will be advertised for bids as soon as funds are made available.

The 1961-62 budget contains $13,700,000 for the construction of the Santa Ana, Orange and Garden Grove Freeways interchange. Unit II of this project provides for the construction of the Santa Ana Freeway between the Santa Ana River and Main Street in Santa Ana to 6 lanes and construction of the Garden Grove Freeway from the Santa Ana Freeway to just east of Main Street.

A median barrier project is financed $535,000 in the 1961-62 fiscal year for the Santa Ana Freeway between Rosecrans and Grand Avenues, 8.7 miles.

Santa Monica Freeway

An Interstate route, the Santa Monica Freeway measures 17.6 miles from Palisades Beach Road in Santa Monica to the Santa Ana Freeway in East Los Angeles. Various parts of this route had been completed in the downtown area in the years 1957-59, including a bridge across the Los Angeles River and the Atchison-Topeka-Santa Fe and the Union Pacific Railways and bridges across the Harbor Freeway.

Going and completed projects and right of way costs on the Santa Monica Freeway amounted to $106,035,000 as of December 31, 1960. The section from the East Los Angeles Interchange to Vermont Avenue is all under construction (mainly viaduct) covering a distance of 4.9 miles and representing a combined construction cost of $37,166,000. The target date for completion of the Santa Monica Freeway as far west as Vermont Avenue is fall 1962. (For details on Santa Monica Freeway construction see article "Loop Progress," by A. L. Himelhoch, District Engineer—Operations, *California Highways and Public Works*, January-February, 1961.)

As a means of offering further freeway service to the westerly section of metropolitan Los Angeles, work on the Santa Monica Freeway west of the Harbor Freeway has also been expedited. Special emphasis has been placed on completion of the section between the Harbor and San Diego Freeways with the section westerly to the Pacific Coast Highway following closely thereafter. The 1961-62 budget includes $9,860,000 for structures and related work between Hoover Avenue and the Pacific Coast Highway.

Plans for the Santa Monica Freeway as far west as the San Diego Freeway are scheduled for completion this year. Plans for the remainder west of the San Diego Freeway should be completed early in 1962. An accelerated right of way acquisition program will get under way on July 1, 1961, when $18,700,000 in 1961-62 funds will become available for expenditure.

Santa Paula-Santa Clara River Freeway

The Santa Paula-Santa Clara River Freeway (State Sign Route 126) is adopted in two separated portions, between the Ventura Freeway and Orcutt Road in Ventura County and between the Ventura County line and the Golden State Freeway in Los Angeles County, for a distance of almost 20 miles.

Plans for the first section of the Santa Paula-Santa Clara River Freeway from the Ventura Freeway to 0.1 mile east of Wells Road, 5.5 miles, have been completed, and it is anticipated that bids will be received in the early summer of 1961. This project is budgeted for $3,600,000 in the 1961-62 fiscal year.

Plans for the second section from 0.1 mile east of Wells Road to the east city limits of Santa Paula are nearing completion.

For the Santa Paula-Santa Clara River Freeway from the Ventura County line to the Golden State Freeway, right of way is being acquired in conjunction with a project proposed on the Golden State Freeway.

Ventura Freeway

The Ventura Freeway is 75.6 miles long in District VII, extending from the Golden State Freeway in Los Angeles County, through Ventura County, to the Santa Barbara County line. Sections of this route are constructed, under construction or in design stages. Up to December 31, 1960 a total of $97,447,000 had been expended on this route for right of way and construction on going and completed contracts.

Two important Ventura Freeway links were completed in 1960, between Laurel Canyon Boulevard and the San Diego Freeway and between Encino and Kelvin Avenues in the San Fernando Valley, adding about 8 miles to this route at a construction cost of $12,552,000. These two contracts were opened simultaneously to traffic on April 5.

Other completions on the Ventura Freeway in 1960 are as follows: landscaping, Sepulveda Boulevard (San Diego Freeway) to Encino Avenue, 2.6 miles, March 10, $195,000; landscaping, Kelvin Avenue to the west city limits of Los Angeles, 3.5 miles, March 23, $36,000; landscaping, Ventura Boulevard to Burbank Boulevard, 1.2 miles, April 26, $40,000; ramps and freeway widening, Colfax Avenue to Laurel Canyon Boulevard, June 30, $361,000; median barrier, Laurel Canyon Boulevard to Sepulveda Boulevard, July 15, $85,000; and landscaping, Moorpark Street to Colfax Avenue, 0.9-mile, November 22, $23,000.

Preparation of contract plans and active construction continues on the Ventura Freeway between the Los Angeles city limits and the Santa Barbara County line. A contract through the City of Ventura, 4.6 miles, was awarded for a bid price of $8,948,400 on February 24, 1960. This section, which calls for 10 bridges, 1 pumping plant and 13 retaining walls, will have 6 lanes (with provision for more) from Telephone Road to Palm Street. With actual work having started on March 14, 1960, the estimated completion date is March, 1962. Major quantities on the job are 2,300,000 cubic yards of imported borrow and 750,000 cubic yards of roadway excavation.

An adjoining project, totaling 4.2 miles and including interchange structures with a short length of the Ojai Freeway, was awarded on February 14, 1961, at a low bid of $6,506,432. This connecting link of 4 and 6-lane



Looking northerly at construction in progress on the Ventura Freeway in the City of Ventura.

STATUS OF DISTRICT VII FREEWAY PROJECTS

SUMMARY AS OF MARCH 1, 1961

Name of freeway	Route No.	Total adopted miles	Completed projects				Under construction		Right of way cost	Total obligated cost to date
			Freeway		Expressway		Freeway			
			Miles	Cost	Miles	Cost	Miles	Estimated cost		
Antelope Valley*	23	54.6		60	0.3	450		7,620	697	8,827
Artesia	175	18.9		828	4.9	2,324			5,272	8,424
Colorado	161	2.3	2.3	6,325					2,275	8,600
Corona*	77	4.4			3.2	837			231	1,068
Corona Del Mar	184	6.3			2.2	215			68	283
Foothill	157,9,190	34.2	2.3	2,287					2,846	5,133
Garden Grove*	179	15.4		1,566				271	5,620	7,457
Glendale*	162	3.2	1.1	2,914			1.3	3,156	6,726	12,796
Golden State	4,161	73.2	11.3	26,241	43.6	6,901	15.9	46,004	67,435	146,581
Harbor	165	22.6	17.7	42,280			4.5	7,143	52,766	102,189
Hollywood	2,159	17.3	10.9	33,924				21	35,026	68,971
Laguna*	185	8.4				570			138	708
Long Beach*	167	21.5	16.8	27,982			2.9	4,948	23,016	55,946
Marina	60	2.6							40	40
Newport*	43	17.7			3.3	1,772	3.0	4,400	7,190	13,362
Ojai	138	6.0	2.7	1,360	0.9	376	0.2	696	1,552	3,984
Orange	19	16.6							1,816	1,816
Pacific Coast	60	24.3	7.9	2,530				10	2,809	5,349
Padadena*	165,205	8.2	8.2	10,794				410	1,014	12,218
Pomona*	172,19	28.8							4,213	4,213
Riverside*	175,43	19.1	5.7	6,248	13.4	3,920			5,676	15,844
San Bernardino*	26	30.6	30.6	39,034				4,047	17,704	60,785
San Diego*	2,158	92.5	29.1	42,212			14.7	46,919	87,785	176,916
San Gabriel River	170	22.6		190					16,867	17,057
Santa Ana	2,174,166	43.1	43.1	54,071				880	19,357	74,308
Santa Clara River	79	19.9							1,846	1,846
Santa Monica*	60,173	17.6		5,510			4.9	37,166	63,359	106,035
Seaside	167	2.2							514	514
Slauson	221	0.6								
Ventura*	161,2	75.6	24.9	33,933	29.7	7,790	9.7	18,794	43,376	103,893
Yorba Linda	176	3.1							529	529
Totals		713.4	214.6	340,289	101.5	25,155	57.1	182,485	477,763	1,025,692

*Official name.

(Cost in $1,000)

freeway is being built west of Palm Street and it is anticipated that it will be completed by late fall of 1962.

Urban development along the present Ventura expressway has been explosive with a corresponding increase in traffic. Opening of the last two sections of the Ventura Freeway in the San Fernando Valley accelerated to a marked degree this increase in traffic. The 1960 July traffic count shows a 35% to 50% increase in traffic over the 1959 count for the entire length from Los Angeles to Ventura. This has created a conflict at the crossings at grade with resulting needs for separations of grades at the principal intersecting streets.

Right of way is being acquired and plans prepared for converting this section to full freeway with construction of interchanges and elimination of present crossings at grade. A $529,300 contract for the interchange at Las Posas Road in the vicinity of the Oxnard Air Base was awarded on December 22, 1960.

At Moorpark Road, construction of the interchange will be combined with reconstruction of 3.5 miles of Moorpark Road (State Sign Route 23) as far as Olsen Road. This project is financed $1,340,000 in this fiscal year with construction to start in the summer of 1961. Similar interchanges are financed for construction along the Ventura Freeway at Borchard Road, 1.7 miles, $599,000; and at Las Virgenes Road, 1 mile, $380,000.

West of the Ventura River to the Santa Barbara County line details are being completed for a 4-lane freeway on revised alignment with right of way for an ultimate 6 lanes.

Major construction projects on the Ventura Freeway are in progress in the Los Angeles area as well, with two contracts that will connect the Ventura Freeway to the Golden State Freeway at the north end of Griffith Park.

The first contract, awarded on November 7, 1960 at a bid price of $3,915,600, extends from the Golden State Freeway to Buena Vista Street and includes construction on 1.9 miles of the Golden State Freeway to the Colorado Street extension (widening to 5 lanes of the southbound roadway) and 2.2 miles on the Ventura Freeway. This project will have 6 equestrian undercrossings and 4 bridges for vehicular traffic, one a

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MacDONALD RETIRES; O'BIER, ASBILL PROMOTED

Ernest M. MacDonald, Assistant Chief Right of Way Agent in charge of appraisals for the California Division of Highways, retired on May 2 after nearly 30 years of State service.



E. M. MacDONALD

To succeed MacDonald, State Highway Engineer J. C. Womack has announced the promotion of Ray E. O'Bier of San Bernardino, who has been in charge of highway right of way activities in the San Bernardino-Riverside County district since 1945.

O'Bier's successor as District Right of Way Agent is J. M. Asbill of San Bernardino, who has been O'Bier's assistant in charge of administration.

MacDonald, as chief of the appraisal section of the Division's Right of Way Department since 1947, has been responsible for the evaluation of hundreds of millions of dollars of property acquired by the State for freeway and other purposes.

He was born in Oakland and educated in Berkeley. He was graduated from the University of California at Berkeley in 1920 after serving overseas in World War I, and then worked as an appraiser for the Southern Pacific Railroad from 1921 to 1926. He later engaged in the real estate and insurance business in Oakland.

He entered State service in 1931 as a Senior Engineering Aid and subsequently became an Assistant Right of Way Agent for the Division of Highways in the Los Angeles area. In 1936 he transferred to the State Board of Equalization, where, as senior valuation engineer, he was in charge of land appraisals for utility assessment throughout the State. He returned to the Division of Highways as its appraisal chief in 1947.



RAY E. O'BIER

MacDonald served with the 363rd (San Francisco's own) Infantry Regiment in France in World War I. He was wounded in action in the Argonne campaign and was awarded the Silver Star and Purple Heart.

He is a member of the American Society of Civil Engineers, the American Institute of Real Estate Appraisers, the American Right of Way Association, and the State Men's Club of Sacramento.

MacDonald and his wife, Dolores, live at 520 Woodland Drive, North Sacramento. They have three daughters, Mrs. David Ferguson of Colby, Kansas, Mrs. William Neuffer of North Sacramento, and Mrs. Oscar Wiger of West Covina.



J. M. ASBILL

O'Bier, who is moving up to assistant Chief Right of Way Agent, has been an employee of the Division of Highways since 1927, first in engineering work and for the past 26 years in right of way. He rose through the ranks to head the District right of way unit in 1945. For all but one year of his more than 33 with the Division he has been in the San Bernardino District.

He was born and educated in El Campo, Texas, and worked on geophysical surveys for an oil company before coming to California in 1927.

Asbill, who is being promoted to District Right of Way Agent, is also a native of Texas. He joined the California Division of Highways as a timekeeper in 1924, left State service to practice accounting in 1930, returned in 1933, and has been in right of way work in the San Bernardino District since 1943.

The State Division of Highways has opened bids on a project covering grading and surfacing on State Sign Route 89 in Plumas County and construction of 6.5 miles of two-lane access controlled highway between two miles north of Canyon Dam and 1.3 miles north of Almanor Inn. Seven bids were received. Low bidder was Baldwin Contracting Company, Inc., Marysville, $536,701.80.

DISTRICT VII—Continued

385-foot steel girder structure over the Los Angeles River. The estimated completion date for the entire project is April, 1962.

On March 23, 1961 bids were opened for that portion of the Ventura Freeway from Buena Vista Street west to connection with existing Ventura Freeway at the Hollywood Freeway interchange in Studio City. This project is 2.9 miles long and is financed $7,700,00 in the 1961-62 fiscal year. The project will have 14 bridges and 1 pedestrian crossing.

Minor projects in progress on the Ventura Freeway include the following: median barrier, Hollywood Freeway to Laurel Canyon Boulevard and Encino Avenue to Reseda Boulevard, 2.4 miles (bid opening held on March 30, 1961, from $55,000 available in 1961-62 funds); landscaping, Encino Avenue to Kelvin Avenue, 4.2 miles covering 42 acres, $135,000, scheduled for completion in September, 1961; and landscaping, at Ditch Road, Calleguas Road, Pleasant Valley Road, Dempsey Road and Wood Road, 10.2 miles covering 10.4 acres, scheduled for completion in July, 1961.

Future Outlook

Today we have in operation a portion of a true freeway system in a major metropolitan area. In 1961 we will still have only a portion, not many miles longer than in 1960. But by the latter part of 1962, with completion of a substantial mileage of major freeway projects now under construction, there will be an extended system and a choice of freeway routes available to the motorist.

In the meantime, orderly planning for additional freeways to serve all sections of the three-county area of District VII is continuing, while the Los Angeles Regional Transportation Study continues as a basis for comprehensive metropolitan planning on the part of the State, the cities and the counties in the area.

The sensible application of safe driving practices is the surest defense against motor vehicle accidents of any type.

Seattle Public Library
MAY 9 1961

Scotia Bridge

Parallel 2-lane Structure Corrects Traffic Deficiency

By GEORGE W. THOMSON, Resident Engineer



With the opening of the South Scotia bridge over the Eel River on December 6, 1960, one more step was realized in the ultimate development of the Redwood Highway (U. S. 101) to freeway standards.

The project consists of a new parallel bridge with approach roadways 75 feet downstream from the existing Eel River bridge. The new bridge provides a 28 foot roadway for 2 lanes of southbound traffic while the existing bridge will continue in service providing one northbound lane. The project extends from 0.4 mile south to 0.2 mile north of South Scotia Bridge, approximately 3 miles south of the town of Scotia. The length of project is 0.72 miles.

The existing South Scotia Bridge was constructed in 1916 under State Contract No. 166 by Mercer and Fraser, Contractors, for the bid amount of $120,407. It consists of two 304-foot through pin-connected steel truss spans over the river channel, and reinforced concrete slab and girder approach spans, providing a minimum roadway width of 18 feet.

With the increase in size, weight, and speed of trucks over the years, it became necessary to post the bridge; this was done in 1937, consisting of "5 MPH on Bridge for Vehicles over 5 Tons"—it was also signed "One Way for Trucks and Buses". In 1940, the original timber deck on the truss spans was replaced with a reinforced concrete deck, and the structural steel floor system strengthened.

Some Structural Damage

On several occasions the truss members suffered structural damage, as the result of "tight squeezes" between logging trucks and cars meeting on the bridge. To protect the truss a pair of skid rails (corrugated metal plate guard rail section) were placed in 1952 on each side of the roadway, attached to the truss members at truck load height. Although the old bridge is structurally adequate for legal loads, the speed restriction posting for northbound traffic over the old bridge will remain in effect. Ultimately the old bridge will be replaced by a structure similar to the new bridge.



Under view of the new parallel South Scotia Bridge (right) over the Eel River. Located some 75 feet downstream from the old bridge (left), which was built in 1916, the new bridge is 1,000 feet long and has two spans (each 304 feet long) of continuous steel deck truss construction over the river channel.

The Eel River channel is about 600 feet wide at this location. Flow varies widely with season and run-off conditions. During the summer months the flow is only about 200 second-feet but during the winter rainy season it can be a different story. During the disastrous December 1955 flood the maximum discharge was estimated at 200,000 second-feet.

The new bridge consists of a two span continuous steel deck truss over

the river channel (2 @ 304′ 4″), matching the river spans of the existing bridge with welded steel plate girder approach spans (3 at each end of truss, averaging 64 feet). The total length of the bridge is 998′ 9½″. The alignment is tangent and parallel to the old bridge, except for a short section of curve to left at north end of the bridge. The first approach span on the north end of the bridge is over the single track mainline of the Northwestern Pacific Railroad, hence the structure designation "Eel River Bridge and Overhead".

Welded Sections

The Warren type steel deck truss has 10 panels @ 30′ 5″ per span. All members are welded H sections. Chords are parallel; truss depth is 30′ 0″; the 2 trusses are spaced @ 20′ 0″. A fixed bearing with 10″ diameter pin is used at center pier; rocker assemblies are used at end piers.

Two types of structural steel were used for the truss: ASTM Specification A242 for main stress carrying members with an allowance tension stress of 27,000 to 22,000 p.s.i. dependent upon plate thickness—the lower value for plates over 1½″; ASTM Specification A373 steel was used for all other members, with an allowable tension of 18,000 p.s.i. Both steels are suitable for welding the built up members. 510,000 lbs. of A242, and 663,000 of A373 steel were required. All connections are made with ⅞″ high strength bolts. The reinforced concrete deck is 6¼″ in thickness, and is supported by 5 stringers (27 WF @ 94) spaced @ 6′ 6″ per truss panel span. Floor beams and stringers are A-7 steel.

Approach spans consist of 4 welded steel girders, 39″ web depth, spaced at 8′4″ of A-7 steel.

The Bridge substructure consists of reinforced concrete abutments and piers on cast-in-place concrete and steel piling.

The bridge is designed for H20-S16-44 and Alternate loading, in conformance with American Association of State Highway Officials Specifications supplemented by Bridge Department specifications. It was designed by the Bridge Department of the Division of Highways at Sacramento under the direction of recently retired Bridge Engineer F. W. Panhorst.

The roadwork consists of approaches to the new bridge, transitions to existing two lane facility, frontage roads, creek channel alignment, and sacked concrete riprap bank protection for north end of south approach embankment.

Contract Is Joint Venture

The contract was awarded to the joint venture firm of Erickson, Phillips and Weisberg of Concord; and Arthur B. Siri Inc. of Santa Rosa for the bid amount of $984,227 on May 22, 1959. Work started on the project on May 26. Erickson, Phillips & Weisberg did the bridge work; Arthur B. Siri Inc. handled the roadwork.

The Special Provisions for the contract provided for a settlement period at the south approach fill not to exceed 30 days before the driving of piles for the south abutment of the bridge. For varying depths the surface material at this location consists of silty sand mixed with forest debris, such as old logs and decomposed vegetation; this cover is underlain by solid material consisting of sand & gravel graduating to shale. The area at one time was the ancient river channel. It was found at the end of the 30 day period, that the fill was still settling; the height of the fill at this location is about 45′. The fill finally stabilized in about 75 days, with a total movement of 3.6 feet.



The new South Scotia parallel bridge (right) over the Eel River has a 28-foot roadway which carries two lanes of southbound traffic. Northbound traffic will use the old bridge (left).



Looking upstream at the new (front) and old (rear) South Scotia parallel bridges over the Eel River. Ultimately, the old bridge will be replaced by a structure similar to the new one.

All piles were driven to a 45 ton minimum bearing capacity, excepting abutment No. 1 which was to 60 tons. Steel piles (10 BP @ 42) were used at abutment No. 1 and river pier No. 5; at all other locations cast-in-place concrete piles were used, except at pier No. 6. Pier 6 is supported by a spread footing @ 6 TSF on a dense shale outcropping. Foundation requirements on this job varied considerably; it is noted that conditions encountered agreed closely with investigation and recommendations made by the Bridge Department Geology Section. Furnishing and driving piles was subcontracted to Raymond Concrete Pile Co. of Oakland.

River piers consist of constant section reinforced concrete shafts, 29′x6′, with 3′ radius noses, and a single hollow cell 16′x3′6″. The maximum pier height is 73′, pier No. 5. Conventional forming methods were used, pouring each pier in 3 lifts.

Falsework Towers

Two leg steel falsework towers at 60′ (even numbered truss panel points) were used to erect the structural steel. The average tower height was 65′; the tower legs were supported by steel plate pads on channel bottom. The falsework bents were used initially for span 4. When erection and bolt-up of span 4 was complete, the towers were removed, excepting one @ PP6 to retain camber, and repositioned in span 5; erection and bolt-up work was then continued. A 65 Ton capacity (4 axle) truck crane was used to erect structural steel; it was equipped with a 110′ boom and 25′ jib. It was necessary for the Contractor to ship this large crane by rail from the Bay Area to the job site, as a highway travel permit could not be issued due to poor alignment of Highway 101 north of Ukiah, and the heavy summer tourist traffic. A center of span erection camber of 4″ was provided in the 304′ spans. After all falsework was removed, and the concrete deck and curbs placed, the residual camber was found to average 1¾″.

The major roadwork items and the bridge, except for painting of structural steel, was completed in December 1960. The new bridge was opened to public traffic on December 6. The structural steel is being painted with an aluminum finish coat, to match the adjacent old bridge. All work was completed on March 2, 1961.

The approximate cost of the bridge work is $664,000; and the roadwork is $353,000. This is a California Federal Aid Primary Project, No. F-0118(2). The Federal funds amount to 55.12% of the total value of the work.

Ross Phillips of Erickson, Phillips and Weisberg was the Project Superintendent for the Contractor. The project was administered by the Bridge Department, Division of Highways under J. E. McMahon, Bridge Engineer. Representing the State in the field were Resident Engineer George W. Thomson, and District I Representative John Brown, Jr. (1959), and Leland Hadley (1960-61).

The California Highway Commission has adopted a freeway routing for a beltline freeway running north of Sacramento which will form a component part of a proposed freeway network in the metropolitan area.

The adopted route is 16.5 miles in length.

Aukum Road

El Dorado County Completes Difficult Route Relocation

By ROBERT C. DOWNER, Road Commissioner

An excellent example of a county designed and cooperatively financed Federal-aid Secondary Highway and Bridge Project in rough mountainous country is found about eight miles southeast of Placerville where El Dorado County's Aukum Road (FAS Route 1234) crosses the north fork of the Cosumnes River.

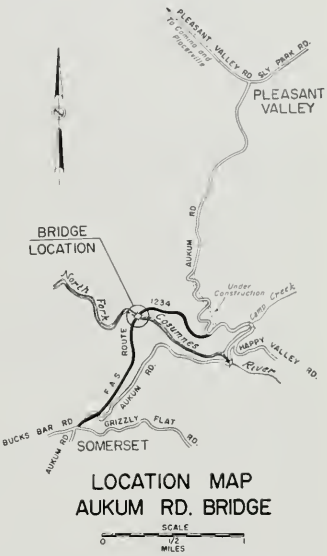
The outstanding feature of the project is the new bridge on a graceful curve high above normal water level. Its wide concrete deck is supported by steel girders on concrete piers and abutments. Located ¾ mile downstream from the old bridge, the new structure is on a 1.5-mile realignment between Somerset and 0.7 mile north of the river in precipitous terrain which includes ledges and boulders of granite.

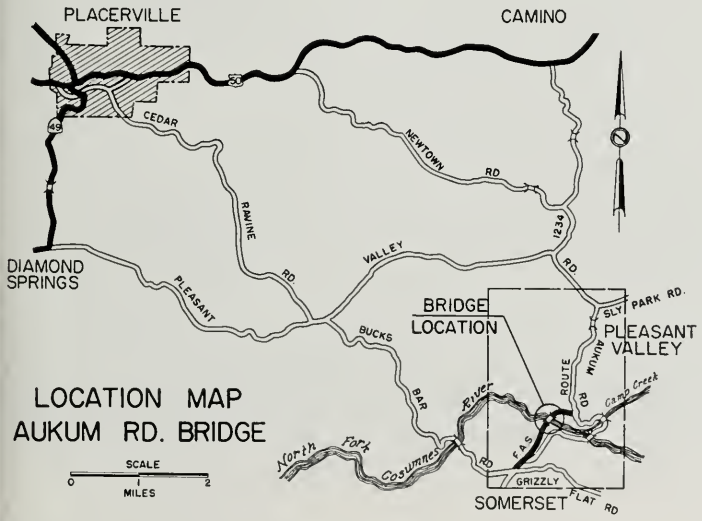
In fact, so rugged is the country that the grading contract had to be let and completed before the bridge contract could be started, since access to the bridge site was impossible for construction equipment.

Had Many Curves

Previously, the alignment was two-and-one-quarter miles of 18-feet-wide oiled earth with two-foot shoulders. Curves were as tight as 40-foot radii and grades ran up to 12 per cent. The old bridge over the Cosumnes, which remains in place for local traffic, is 38 feet long and 20 feet wide on a substandard alignment. The Camp Creek bridge consisted of one 112-foot steel truss span with timber approach spans for a total of 177 feet. It was 12 feet wide with two planks for each wheel track.

The new alignment provides a minimum curve radius of 400 feet, a nine percent maximum grade, a roadbed width of 28 feet, and saves three-quarters of a mile of travel distance. The new bridge has a reinforced concrete deck over three 85-foot welded girder spans supported on reinforced concrete abutments and single-column piers, and provides a clear roadway of 28 feet. The deck is about 75 feet above the normal water surface of the stream. The old bridge, which it replaces, had a posted weight limit of only five tons. The new structure has no posted weight limit.





Pier footings in the essentially solid granite required drilling and blasting. The concrete was anchored to the rock with steel dowels.

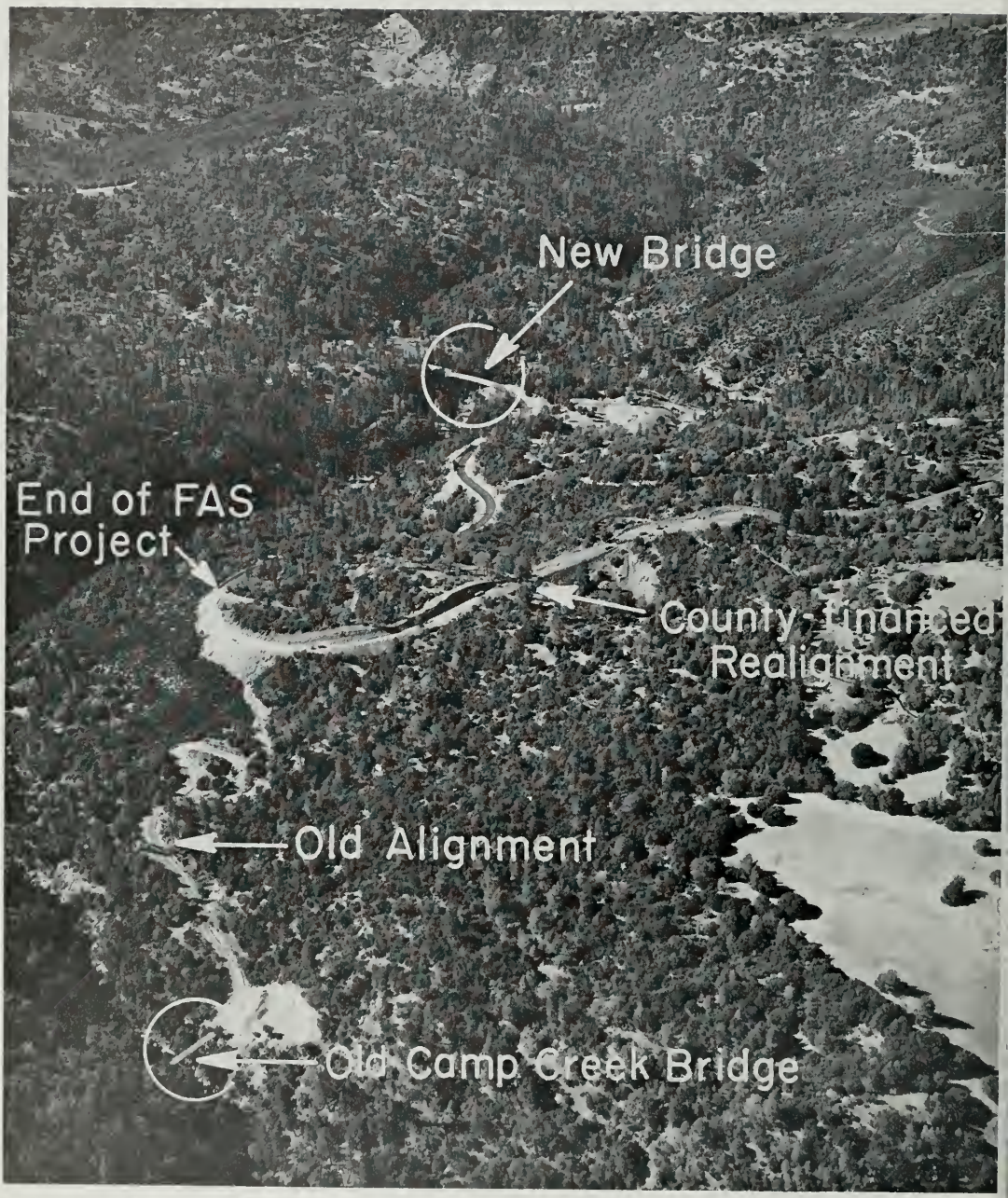
The placing of girders by truck crane went smoothly, although the steel strike from June to December of 1959 caused a backlog on orders resulting in a 77-day time extension.

Roadbed Is Surfaced

Following completion of the bridge in September 1960, the County surfaced the roadbed of the new alignment at its own expense.

Together, the three-phase project—grading, bridge, and paving—integrates nicely with the County-wide planning program for this important lumber, mining, and recreational area.

Lord & Bishop of Sacramento was the prime contractor, and Edward G.



An aerial view of the construction area looking westward. The new highway bypassed an old circuitous alignment and two substandard bridges, the Old Camp Creek Bridge (foreground) and the Old North Fork Cosumnes Bridge (located just out of the photo middle left).



A northward view of the new bridge and the granite streambed and terrain.

Naramore of the Division of Highways Bridge Department was the resident engineer.

The bridge was designed by Robert Thomas, assistant road commissioner of El Dorado County, under the direction of the writer and W. Calvin Kiedaisch of the State Division of Highways Bridge Department.

Review of plans and specifications, and coordination of the project with county, state, and federal agencies, was handled by Donald G. Foster, associate highway engineer, under the direction of Hanlon E. Rhud, District III City and County Projects engineer, with the cooperation of Boyd Sylvester of the U.S. Bureau of Public Roads.

At the present time, with its own initiative and funds, the County is undertaking a major realignment of the route from the north end of the FAS job to about half way to Pleasant Valley. Local logging interests are also giving their interest and support.

Construction Costs Down 0.3 Percent

The California Highway Construction Cost Index for the fourth quarter of 1960 stood at 228.5, a decrease of 0.6 index point or 0.3 percent from the third quarter. According to the Division of Highways, this slight decrease, together with the small fluctuations of the previous three quarters, reflected a period of stability in prices.

A trend toward stabilization in highway costs was also indicated by the behavior of the Bureau of Public Roads Composite Mile Index, which is based on Federal-Aid highway construction contracts awarded by the state highway departments. The index for the third quarter of 1960, the latest available, increased 4.9 points or 2.2 percent. This index has shown small fluctuations during the past year.

Bidder competition in California during the fourth quarter, with an average of 6.2 bidders per project, was slightly higher than in the previous quarter (5.9).

Committee Proposes Scenic Highway Study

A one-year study of proposed scenic highways in California has been recommended to the Legislature after a preliminary investigation by a special Joint Agency Study Group.

The special study, authorized by Senate Resolution 26 (1960), was conducted by a committee composed of representatives of the State Departments of Public Works, Natural Resources and Water Resources, and the State Office of Planning.

In a recently published report, the group recommends that the Legislature affirm the intention of setting up a separate class of scenic highways within the state highway system.

It also recommends a one-year study similar to the study which formed the basis for the establishment of the California-Freeway-Expressway System (SCR 26 Study, 1957).

Purpose of such a study, the report states, should be to "identify, delineate and evaluate" scenic corridors and routes throughout the state. Consideration of design and planning procedures, legal questions, land acquisition, and land use and zoning is also recommended.

Rural Fringe

Freeway Speeds Increase In Land Use, Land Value

A REPORT OF THE LAND ECONOMIC STUDIES SECTION RIGHT OF WAY DEPARTMENT

Summation by BAMFORD FRANKLAND, Headquarters Right of Way Agent



"In the development of California's freeways, a problem of great significance has been, and will continue to be, the economic effect this modern facility will have upon the land through which it passes and the community it serves."

This was the lead paragraph of a pioneering land economic study article by John F. Kelly, entitled "Residences and Freeways" which appeared in the March-April, 1957 issue of *California Highways and Public Works*. It requires no further elaboration, nor does the paragraph which followed it:

"It has been generally accepted that a freeway facility, by its reduction in travel time, brings within the scope of development areas which otherwise could not be developed."

Purpose of Study

"Residences and Freeways," as the title implies, explored the relationship between homes and adjacent freeways by means of a tabulation of sales prices of individual homes. The purpose of the present study has been to explore the relationship between undeveloped land and the freeway; to trace the pattern of development leading to the ultimate construction of homes and other improvements in a rural area adjacent to a freeway which serves a growing metropolitan center; and to thus determine the results of a reduction in travel time. The study will additionally show, by comparisons with areas not influenced by a freeway, what development might have been in the study area if a freeway had not been built.

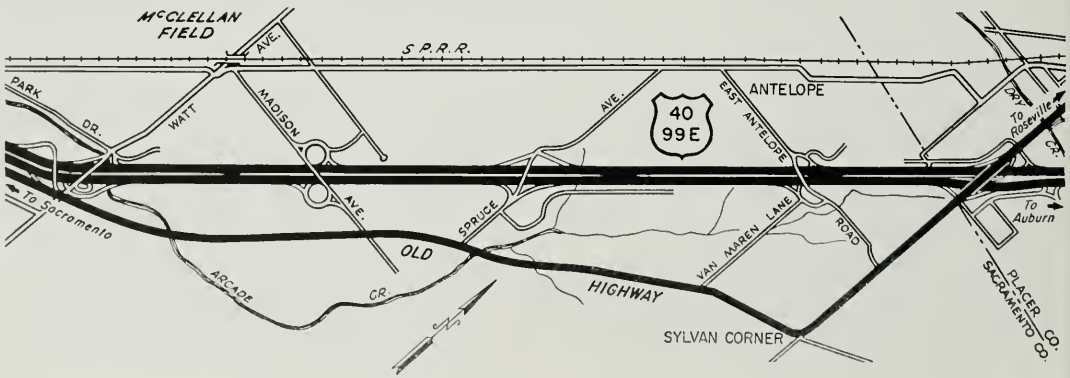
The Study Area

The area chosen for study was, prior to freeway construction, essentially rural in character. It lay adjacent to U.S. Highway 40, Northern California's main, east-west, transcontinental highway which passes through Sacramento, the capital of California, on its way from San Francisco to the California-Nevada border near Reno.

Prior to 1956 the study area was a part of Sacramento's rural fringe. In it were a number of two to ten acre rural homesites and at a greater distance from the city a band of medium sized farms ranging between 80 and 320 acres. In this respect it was similar to other peripheral areas of the city. It was slightly rolling and randomly studded with mature oak trees.

Access to the area was via U.S. 40 which was typical of the old routes into many of our cities. It was a conventional two lane highway which was being forced to serve a dual function and doing both jobs poorly. Local commuter traffic in growing numbers used the highway as well as ever increasing amounts of through traffic, including large numbers of heavy trucks. Small businesses catering to both classes of highway users had sprung up along the length of the road between Sacramento and the City of Roseville, 13 miles away. This ribbon development caused many conflicting traffic movements and seriously hindered the orderly passage of traffic.

The short trip between Sacramento and Roseville came to consume as much as 45 minutes and exasperated and endangered many a motorist. There were many undeveloped agri-



The above map shows the portion of the Roseville Freeway studied in the accompanying article.

cultural areas in and around Sacramento which were much quicker and easier to reach and developers naturally tended to take the paths of least resistance. New homes, businesses and industries gravitated to other areas of better access.

The rapidly spreading metropolitan growth of Sacramento thus did not include the area adjacent to the old highway. The study area, which paralleled the old highway for 7.5 miles was, in effect, closed to development because of poor access conditions which made speculative development unattractive to potential investors.

The Freeway

The Division of Highways proposed a new full freeway to replace the obsolescent stretch of U.S. 40 between Sacramento and Roseville. It was designed, in part, to provide a congestion free facility for through traffic. Acquisition of access rights and grade separation of major road crossings would eliminate the conflicts which rise from a mingling of local shoppers, commuters and through traffic. The accompanying map shows the location of the new freeway which essentially parallels the old road but which cuts directly from Sacramento diagonally through the study area to Roseville.

Local, as well as through, traffic would be able to use the new facility and would be served by means of frequent traffic interchanges with the major county road crossings. The diversion of traffic from the old highway to the new route would, in addition, increase the capacity of the old highway to carry local traffic and would have the effect of providing two alternate and swift means of access to the study area. Construction of the new route began in 1953, and it was opened to traffic early in 1956.

Time Period of Study

Data covering the years between 1946 and 1960 was collected for use in this study. The time period begins at a time, seven years prior to completion of the freeway, when land in the area was being devoted primarily to agricultural uses. It ends seven years after completion of the freeway when the transition to more intensive land uses is virtually complete. The fourteen year study period allowed the use of the trend method of examination of land value changes which are most indicative of the startling changes which have actually occurred in the area.



Looking east toward Roseville along the section of freeway covered by the study. The old highway is between the lines of trees to the right.

Study Procedure

There were sixty-one rural homesite or farm properties lying adjacent to the freeway which formed the reservoir from which data regarding land use and land value changes have been drawn. Of these sixty-one properties, fifty had been sold one or more times during the fourteen year study period for a total of seventy-one sales. Each sale was researched in the public records, the properties were inspected and owners and former owners were interviewed. The circumstances of each sale were carefully investigated to permit elimination from consideration of any which were not indicative of a fair and open transaction.

The inspections and interviews permitted conclusions to be drawn regarding present and future uses for the properties and the researching of public records and interviews with owners permitted the tabulation of sales price trends which are vividly indicative of the growth trend in the area.

Control Areas

The investigations and tabulations in the study area documented what actually happened to land uses and land values. The pattern of development and its pace became clear. These tabulations did not reveal, however, what would actually have occurred if the freeway had not been built when and where it was.

To determine what would have happened to the study area in the absence of the freeway it was necessary to use a comparative base or control area. Ideally, a control area is an area, away from any possibility of influence by the freeway, which is similar, including attractiveness for development and accessibility to the area with which it is being compared. Its value levels should be about the same and the future potential should appear to be for the same uses. Distances to major employment centers, shopping areas and other public facilities, such as schools should be very similar. In essence, the economic forces of change

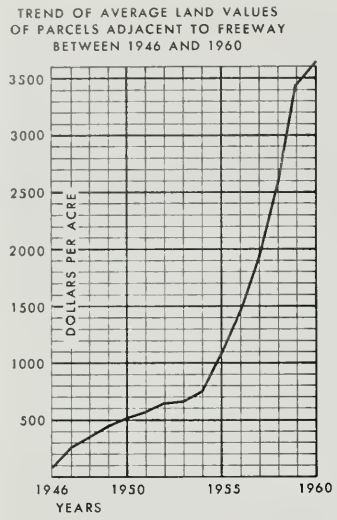


Chart 1. This shows the 14-year trend of raw land values in the area adjacent to the Roseville Freeway. The trend follows the normal pattern of value increases in a rapidly developing area.

which act upon the study and control areas should be the same with the only variable being the presence or absence of the freeway. The difference in degree of change between the study and control area should then reveal the influence exerted by the freeway.

Three separate control areas were chosen for use in this study. Each was similar, in all important respects to the study area. One hundred and fifty sales of comparable properties were investigated in the three control areas using the same methods used in the study area.

Study Area Price Trend

The sales prices of properties in the study and control areas were weighted by the amount of land in each sale to reduce the variable introduced by differences in size to a minimum. The weighted prices were then averaged for each year during the study period. The yearly weighted averages were statistically treated to achieve a smooth trend line which would be indicative of the pattern of growth in each area. Chart one depicts the trend line which was plotted for land prices in the study area adjacent to the Roseville Freeway. Prices per acre are shown on the vertical lines of the chart while years are laid along the horizontal line.

Rapid Value Change

The trend line begins in 1946 at a time when land uses in the study area were almost purely agricultural. The average price level of seventy dollars per acre reflects this use and reveals little potential for more intensive and valuable uses. Sales activity during the years prior to 1956 was minimal but the few sales which did occur in the area were at ever increasing prices reflecting a growing amount of interest in the future possibilities for more valuable uses. By 1953, the year freeway construction began, average prices per acre were nearly seven hundred dollars. The increase of nearly one thousand percent in seven years indicates that considerably more than ordinary forces of inflation were acting upon the area. During this same period agricultural land prices for land similar to that in the study area rose only nineteen per cent.

The force causing the skyrocketing of prices in the study area was speculative activity. Investors were betting on the future potential of the area although no actual development had taken place which would appear to justify their faith. An observer would have noted no outward change in the appearance of the area. Farming activities were being carried on as usual. The number of sales definitely increased in 1954. At that time the trend line took an upward turn indicating the increased demand for properties in the study area.

Changes Became Apparent

It was not, however, until 1955 that changes on the ground began to be apparent. At that time a pioneer development firm acquired a large acreage surrounding a future traffic interchange location. Construction of tract type homes was started and timed to coincide with the opening of the freeway. It is of interest to note that this first development began nearly two miles beyond the rural homesite fringe and almost four miles from the next nearest surburban residential development.

The completion of the freeway and the opening of the first tract of homes adjacent to it combined to act as a catalyst of sales activity. By 1956 average prices had increased to over fourteen hundred dollars per acre. In 1958 they had nearly doubled again to almost twenty six hundred dollars per acre and in 1960 the average had gained another one thousand dollars to reach a level of nearly thirty six hundred dollars per acre. The average price level appears to be reaching a point of stabilization as sales activity is tapering off and development under existing ownerships intensifies.

Actual transitions from agricultural to more valuable and more intensive uses have increased rapidly since the opening of the first new home tract. In a short four years (1956-1960) the transition period is nearly complete. Some construction has started on nearly every parcel which was formerly devoted solely to farming. Of all the farms adjacent to the freeway, only one has been retained intact by the original owner and even in his case he has virtually ceased to farm

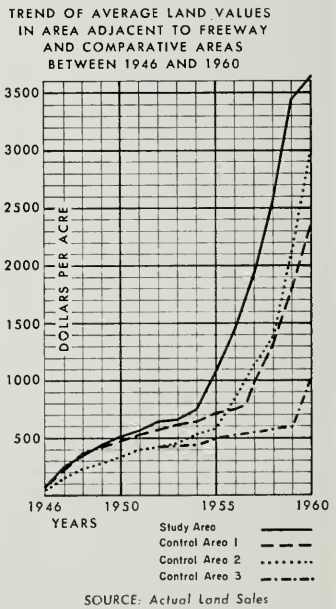


Chart 2. This shows the 14-year trend of raw land values in the study area and three similar control areas and illustrates the accelerating effect of the Roseville Freeway upon adjacent land development.

the property and shortly contemplates the start of a residential subdivision.

Zoning regulation has prevented changes from farm to industrial uses but some changes, other than to residential subdivisions have occurred, including transitions from farms to theater sites, golf driving ranges, cemeteries and apartment house locations.

Control Area Development

On chart two the price trend histories of the three control areas are shown in comparison with the trend already seen in the study area.

Control area one, in 1946-1953, lay just beyond the area of Sacramento's most rapid growth. It almost surely would have been the next most rapid area of development if major changes had not taken place in other areas. It was similar to the study area in all important respects except that it was closer, in time, to major employment centers.

Control area two was also similar to the study area in pre-freeway years. The pattern of growth should have been very nearly the same as in the study area. One important difference might have been expected to accelerate growth in control area two beyond that of the study area. It had two major access roads rather than one. This advantage was balanced however by the fact that the area was slightly less attractive to investors than control area one or the study area.

Control area three was most similar to the study area. They were alike in every important respect save only one. City growth was not apparently expanding as rapidly in adjacent areas as was the situation in the portion of the county near U.S. 40. The two areas were so similar, however, in every other feature that it might be said that—here is what would have happened in the study area if a freeway had not been built.

It can be seen in chart two that all lines diverge although each follows essentially the same pattern. If outside economic forces exerted equal pressures on all areas each of the trend lines should not only have followed the same pattern but they should have done so at the same time.

That the lines did not follow the same pattern at the same time is attributable to several important factors. Development in any community is inevitably irregular as investors balance the various factors affecting their choice of location. It will speed up in one location, then as prices begin to climb it will lag and pick up in another area. Development in one area undoubtedly retards development in another since the market for homes and businesses is not inexhaustible. The overwhelming access advantage provided by the new freeway coupled with quick acquisitions by investors in the adjacent areas slowed acquisitions in other areas.



Looking toward Sacramento from the center of the study area. The subdivision at the center of the photo was the first in the area. Control Area 1 is in the upper left corner of the photo.

Acquisitions Slow Down

Although control area one might have been expected to develop first, acquisitions in the study area apparently slowed it down. When investors switched their attention from the study area to control area one it rose more rapidly in value than control area two but then an important occurrence marred the expected pattern in control area two. A new freeway was proposed in 1953 which bisected this area. Investors were quick to apply the lessons learned during their acquisition activities in the study area. Prior to the completion of the freeway every available parcel of land had been acquired for future conversion to more valuable uses. This caused the trend line for control area two to accelerate at a faster rate than that of control area one and further confirmed the conclusions drawn during the study.

The land value trend lines for the study area and each of the control areas follow a very similar pattern. A period of relatively slow rise precedes a sharp upward break and rapid climb toward maximum economic prices. This pattern is characteristic for a



Looking toward Roseville when construction on the freeway was just beginning in 1954. Compare this photo with the one on page 31.

growing community. As the city expands, speculative activity in the outskirts increases as investors attempt to acquire lands which will lie in the path of future growth. Development then begins and the pace of activity increases driving prices upward until eventually every available property is in the hands of its ultimate developer at which time sales activity of large parcels decreases, subdivision and building increases and prices begin to stabilize at their optimum level.

Summary

The area adjacent to the Roseville Freeway was apparently closed to future development by severe traffic congestion on the only route which led directly to it from major employment centers. Other areas of easier access and similar land prices, the two major controlling factors of transition and development, seemed to have greater potential for future growth. Development in these other areas would eventually have driven their land prices to a level which would make an attempt at development of the study area very attractive even if the Roseville Freeway had not been built. Parenthetically, the economic fact of low prices which make an area attractive to investors would also encourage congestion on already crowded access roads, further compounding a serious problem, and as a consequence cause development to take place at a slow pace while local authorities and private investors undertook to improve access facilities.

The experience of the control areas indicates that the point at which investors might have turned to the study area for possible development would have been approximately the same as has happened in control area three.

What then might have happened in the study area in the absence of the freeway? Development, if it occurred at all, would have been delayed at least five full years.

What, instead, did happen in the area adjacent to the Roseville freeway? Of sixty-one rural homesite and farm properties, fifty have been sold a total of seventy-one times. Every farm property but one has been sold to a purchaser who will devote it to a more intensive and more valuable use. The one will be so used by the original owner. Land use in the area has completely changed in a short four years to a variety of suburban type uses; residential subdivisions, commercial uses, recreational uses, schools, churches and cemeteries. And, most importantly, the property owners have seen these changes accomplished a full five years sooner than have those in other similar areas which are just beginning to experience such changes.

James Thacher Named to CTBA

James F. Thacher, 36, a San Francisco attorney, was appointed to the California Toll Bridge Authority by Governor Edmund G. Brown on March 31, 1961.

He succeeds William M. Roth, San Francisco businessman, who resigned March 23 to accept an appointment by the Governor to the Board of Regents of the University of California.

Thacher is a native of San Francisco and a member of the law firm of Thacher, Jones, Casey & Ball. He also practiced law in New York City for two years, returning to San Francisco in 1953.

He received a bachelor of arts degree in history and economics at Yale University in 1948 and his law degree at the Yale Law School in 1951.

He served with the U.S. Army in the infantry in Belgium and Germany in World War II.

Thacher belongs to local, state and national bar associations and has been active in civic affairs, serving on the budget committee of the Community Chest and on the Mission Community Center Board of Directors.

He and his wife, Gladys, have three children. They reside at 3979 Washington Street, San Francisco.

U.S. 466

First Freeway Section Completed Between Bakersfield and Tehachapi

By M. F. SILVA, Resident Engineer



CEREMONIES conducted by the Tehachapi Post No. 221 American Legion on Sunday, December 11, 1960, marked the dedication of the first section of U. S. 466 constructed to freeway standards between the cities of Bakersfield and Tehachapi. This route, located in Kern County and known as the Tehachapi Highway, is a major cross-continent route carrying a large volume of truck traffic and out-of-state vehicles, as well as local farm to market traffic.

This 11.9-mile, four-lane 60-M.P.H. expressway replaces a 14.5-mile facility which is no longer adequate for present-day traffic due to deficiencies in pavement width, grade, sight distance and alignment. The old highway had a maximum grade of 7% and a minimum curve radius of 300' with a total of 38 curves and a total curvature of 1660 degrees. The new improvement begins in gentle farm lands approximately ten miles east of the City of Bakersfield in the south eastern corner of the San Joaquin valley and ends in the rugged terrain of the Tehachapi mountains some 14 miles west of the City of Tehachapi.

Few Curves

The new facility rises from the elevation 800 feet in the valley floor to 2160 feet in the Tehachapis. About 65% of the overall length is on tangent and only 12 curves, ranging in radius from 2500 feet to 5000 feet and encompassing a total curvature of 290 degrees, are used over its length to produce a design which has been aptly termed "Bold Engineering". The proposed highway grades vary from a minimum 0.12% to a maximum of 6%. A grade of 5% is used on over one-half the length of the project and the longest sustained 5% grade is three miles in length.

Looking west along US 464 toward Arvin Turnoff about 1.7 miles west of Bear Mountain Ranch.





Looking west toward Bakersfield about 2½ miles west of the Arvin Turnoff.



The Caliente Creek Bridge on US 466 about 12 miles east of Bakersfield. The view is westward.

During the early phases of the project, access to a large length of the line was not possible by truck. In the more rugged portions it required several months of roadway excavation and embankment construction before a satisfactory haul road was available for job traffic. The contractor was, therefore, faced with the problem of supplying water for compaction of embankments in the many rugged canyons traversed by the line.

Search for Water

There was no source of water on or adjacent to the right of way. However, several deep producing wells of sufficient capacity for job requirements were situated in farmlands at the western end of the project. In order not to lose valuable time while a well could be developed, the contractor leased an existing well and was delayed only while a pump and motor could be installed and the entire installation tested for adequacy.

The next problem was that of delivering the water to its point of need both for initial embankment construction, subsequent job requirements, and to maintain storage for peak demand. This was met with the installation of 10 miles of 8″ pipeline and six storage reservoirs, four of which were used as booster stations to overcome normal head losses and provide sufficient lift for a 1500 feet difference in elevation between the well head and the most remote reservoir. At each reservoir, as well as at supplemental locations where needed, loading stands were installed to load mobile equipment.

Blasting Required

Largest of the many items of work on this project was upwards of 4,500,000 cubic yards of roadway excavation of which approximately 1,500,000 cubic yards required blasting. Although conventional off-highway earthmoving equipment was used on this and related items, skillful planning was required by the contractor and his subcontractors to overcome the many obstacles presented by the rough terrain existent and to pioneer the line to allow an orderly prosecution of the work.

Of special note is that in spite of the difficulties faced on this and other



A typicol reinforced concrete ditch-check series under operating conditions.



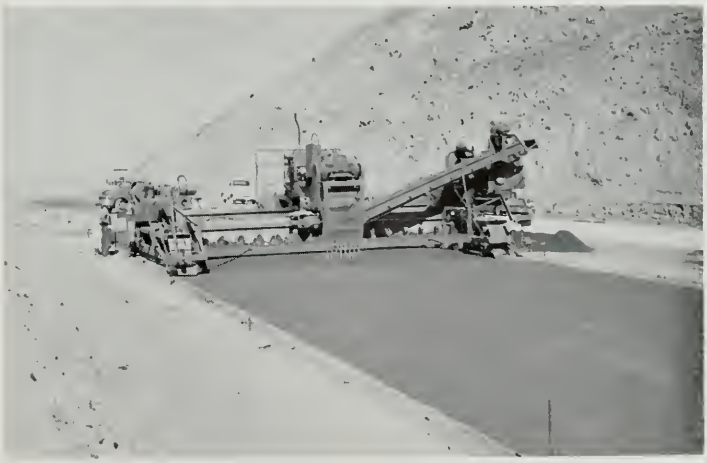
A metol pipe velocity dissipator installed for roadway surface drainage.

items of work, the job was completed without serious injury to personnel.

The project is located largely in mountainous cattle-grazing country, with the exception of the first portion, which is relatively flat cultivated farm land. In the mountainous area about 70% of all drainage areas are on steep slopes with the storm runoff crossing the line in well defined drainage channels. Native soil is highly erosive and the problems of scour and sedimentation are acute. Construction provided wherever possible, therefore, for the conveyance of cross-drainage and roadway surface drainage into existing channels that have been stabilized by natural runoff.

Pipe is Used

To implement this construction 21,321 linear feet of corrugated metal pipe ranging in sizes from 12″ to 54″ were used, supplemented by extensive use of velocity dissipating devices to reduce downstream velocities and to prevent further scouring action in existing channels on adjacent private property. To further augment this drainage system, extensive use was made of velocity retarding ditch checks and special pipe downdrain installations. Additionally, surface ditches and roadway cut benches which will carry significant amounts of surface drainage were paved with asphalt concrete.



A front view af a subgrade trimmer described in the article.

Over 69,000 cubic yards of portland cement concrete were required for the construction of 21½ miles of 24-foot pavement for the project. Paving was by means of a slip-form paver of the type described by Leigh Spickelmire's article in the January-February 1960 issue of this publication. With the use of this equipment and the elimination of conventional header-boards, the contractor was faced with the problem of grade control on cement treated subgrade which was road-mixed.

Subgrade Tolerance

The contract specified that no high subgrade would be allowed and the tolerance for low subgrade was a maximum of .02 on any one theoreti-



Looking east on US 466 about 1½ miles west of the Arvin Turnoff. Coliente Road passes under the freeway in the foreground.

cal days run. Any substantial amount of low subgrade would result in excessive amounts of concrete for which no compensation would be granted. A promising step toward overcoming this obstacle was the development of an electronically controlled and guided subgrade trimmer. This machine is basically a slip-form paver in which the receiving hopper, feed hopper, vibrators and screeds are dropped in favor of a transverse cutting screw, a trimming screed, and a bucket elevator and belt conveyor for discharging the trimmed material outside the subgrade section.

The subgrade trimmer is capable of cutting, within nominal depths, a 26-foot width of subgrade to the established grade in one pass at a rate of travel equal to that of conventional cement treating equipment. Line and grade control is by guide wires which are set in the same fashion as for the paving operation. Exceptionally good grade control was maintained with this machine in its final modified form and its performance contributed to a paving operation which developed a more favorable profile index and smoother riding surface to that constructed over conventional motor grader-trimmed subgrade. Moreover, this control reduced substantially the amount of low subgrade concrete for which the contractor received no compensation.

Experimental Joints

Mention should also be made of experimental longitudinal joint construction performed in conjunction with the slip-form paving operation on a portion of the project. On this section a 2″ wide by .004 thick polyethylene strip was fed into the center of the 24-foot wide pavement in effect forming the longitudinal joint in lieu of conventional sawing methods. The strip is fed directly from equipment mounted on the paver and requires only a minimum of attention for adequate results. The inserted strip produces a very fine crack with only moderate waving throughout the length of joint. Use of the strip substantially reduces the cost of the longitudinal joint.

The contractor on the project was Griffith Company of Los Angeles. W. B. McDonald was the project superintendent for the contractor. The work was under the supervision of W. L. Belch, District Engineer; W. E. Bertken, District Construction Engineer, and M. F. Silva, Resident Engineer. Final construction cost was $5,700,000.

Editor's Note—With Kern County traffic now enjoying the use of the new section described in this article, work is getting started on another major improvement on U.S. 466 in the Tehachapis.

Bids were opened April 5 on a major freeway project which connects with the east end of the new expressway. This project involves construction of 5.8 miles of four-lane freeway between a tenth of a mile east of Caliente Road and a half mile east of Keene.

State Receives Bids On U.S. 466 Freeway

The State Division of Highways has opened bids on a project to grade and pave 5.8 miles of four-lane freeway on U.S. Highway 466 between one-tenth mile east of Caliente Road and one-half mile east of Keene in Kern County. Included in the project are two traffic separation structures (part of interchanges at Keene and Rowen) and a bridge over the Southern Pacific Railroad near Keene. Five bids were received. Low bidder was R. R. Hensler, of Sun Valley, $4,839,024.50.

I.T.T.E. Street and Highway Conference Holds 13th Annual Meet at U.C.

Nearly 600 traffic engineers, planners and government officials attended the 13th Annual Street and Highway Conference January 26-28 at the University of California, Berkeley.

The conference is sponsored each year by the University's Institute of Transportation and Traffic Engineering.

The 1961 meeting consisted of three general sessions, a closing luncheon meeting, and 14 concurrent meetings which featured group discussions covering a wide range of traffic, engineering and management problems.

General Chairman of the three-day conference was John A. Morin, Oakland city engineer. Vice chairmen were Deputy State Highway Engineer J. W. Trask and E. R. Hanna, San Benito County road commissioner. Bob Glenn of the ITTE was general secretary.

The keynote address was delivered by J. O. Mattson, president of the Automotive Safety Foundation, Washington, D. C. Mattson discussed "Communications, a Factor in Good Administration."

"In the interest of safer and more efficient highway transportation," Mattson said, "we need better two-way communication between the various professional groups concerned, as well as between the professionals and the great mass of citizens whose funds support their efforts."

Mattson said there are two necessary phases of communications in any highway agency—the internal information program designed to encourage teamwork and morale within the organization, and external communications which aim to inform and educate the public on highway matters.

Effective internal communications are necessary, he said, to help "mold the character of the organization and influence the quality of its performance." Good external communications are an "obligation," he declared.

"This includes not only the dissemination of facts about how user revenues are being spent," he explained, "but also of essential information about plans, activities and problems. And the manner of presenting the facts is just as important as collection and analysis. They must be made crystal clear to the layman."

Another general session speaker, H. F. Kretcham, editorial writer for the *Salt Lake City Tribune*, also emphasized the importance of effective public communications.

He said an important psychological factor that seems to become involved in highway matters is "fear of change."

Kretcham cited examples of fears which often cause people to oppose badly needed highway improvements such as construction of a freeway or development of one-way streets.

"Often the fear and opposition is unwarranted," he said, "and later so proved. But in dealing with people and their emotional responses we must always remember that it isn't what is true that is important; it is what people think is true."

Kretcham explained that "you have to sell the operation to the patient," pointing out that traffic engineering "is a game where more pseudo-experts call the shots than in a championship football game."

Other speakers at general sessions were State Senator Randolph Collier; Slade Hulbert of the ITTE; Richard M. Zettel of the ITTE; E. W. Blom, assistant city manager of San Diego; Harmer Davis, ITTE director; E. T. Telford, assistant state highway engineer in Los Angeles; and A. S. Koch, Orange County road commissioner.

Collier called for a "positive approach" in the enforcement of traffic laws, with less emphasis on what motorists should not do and more on educating the public about what should be done.

Hulbert used a slide projector and a short film to introduce delegates to the driving simulator, a device now being developed for laboratory study of driver habits and reactions to roadway conditions.

Zettel and Blom talked about the recently completed study of city street deficiencies. Their subject: "SCR 62 Study: Results, Potentialities and Keeping Data Current."

Davis outlined some of the activities of the ITTE. Koch showed a film produced to explain the current Los Angeles Area Transportation Study. Telford presented a film showing traffic conditions in European countries.

One general session featured a panel discussion of "Progress in Cooperation in Freeway Planning." Panelists were Edwin S. Moore, executive vice president of the California State Automobile Association; W. H. Monsen of the Alameda County Surveyor's office; George Bohn, of the U.S. Bureau of Public Roads in Sacramento; R. A. Hayler, Division of Highways district engineer in San Francisco; and Morin.

Speaking at the final luncheon meeting was Wilfred Owen of the Brookings Institution, Washington, D.C. Owen offered a report from an imaginary technical assistance mission to the United States, an "over-developed" country, from the "under-developed" nation of Far-Offistan.

The Far-Offistan representative found many inadequacies in the transportation systems of the United States and offered "respectful" criticisms and suggestions.

Group discussions at the 14 concurrent meetings centered around papers presented by the following:

W. L. Warren, design engineer for the Division of Highways; Jerry Keithley, Palo Alto city manager; Frank Stubbs of the civil engineering department at the University of California; Martin A. Matich, president of the Matich Corporation, Colton; and Vernon Smith, Kern County road commissioner.

Harold Marks, Los Angeles County traffic planning engineer; S. S. Taylor, general manager of the Los Angeles Traffic Department; Michael Carroza, Fresno director of public

. . . Continued on page 72

California Roadsides—2

A MAJOR problem in planting and maintaining planting on California Highways is the cost, which is mounting each year. In 1950-51 for instance, the Division of Highways spent $606,-127 for planting and erosion control, while the 1960-61 budget for roadside planting and landscaping is $4,609,000. This increase is in line with the legislative intent expressed in Assembly Concurrent Resolution No. 132, adopted in June, 1957 and printed herewith.

The much publicized California climate is another big problem, because "sunny California" also means "little rain California" for part of the year. This basic pattern of winter wet —summer dry is constant over the entire state, differing only in intensity. Even in areas of high annual precipitation there is always a long summer drought.

This long summer drought eliminates from consideration for highway landscaping in California more than 90% of the world's plants, as few can live very long without water. Some desirables might survive the drought, but can't stand the heavy winter rains, especially in the heavy poorly drained soils which are common in California. Thus, the plants we can use are few.

EDITOR'S NOTE: This, the second in a series of articles on landscaping and other roadside problems on the California State Highway System, covers the implementation of today's raadside policy. Future articles will cover maintenance problems, and the division's fund of knowledge of plants and trees.

The series has been prepared by John Robinson of the Public Information Section with the assistance of various staff members concerned with planning, planting, and maintenance of roadsides.

Terrain a Factar

Terrain is another limiting factor, with all the micro-climates and soil variation which are found in a state with several major mountain ranges and stretching through nearly 10° of latitude. In California, state highways cross several passes over the Sierra Nevada at more than 7,000 and some nearly at 10,000 feet altitude; in Death Valley and Imperial Valley they go far below sea level. Many mountain roads are literally blasted from solid granite, other highways travel mile after mile of endless desert through sagebrush, greasewood, and cacti. Still others are almost like tunnels through dense forests.



Group of Division of Highwoys landscape architects discuss planting of interchange, including, left to right: Warren Chan, Dana Bowers, Mervin Blacow, Kenneth Buchanan behind James Gordon.

To cope with this tremendous variety of conditions, it has been necessary for the Division of Highways to develop its own experts. Starting with a single employee back in the 1920's, the landscaping section organized under the Design Department, consists today of 10 well trained landscape architects and draftsmen. H. Dana Bowers, who was the entire section in 1929, has continued in charge. Some of Bowers' work in slope erosion control has received international attention, and his hard-earned knowledge is being passed on to the younger men.

Two Types of Planting

During the years of the development of California's current roadside policy, two types of planting have been adopted—"functional planting" and "urban landscaping." In general, "functional planting" is basically utilitarian, as its name indicates, while "urban landscaping" goes beyond pure function and seeks aesthetic effects as well.

The modern uses of functional planting could be said to be an outgrowth of the early day roadside tree plantings for road surface protection from the sun, for these trees were actually functional. However, generally speaking, the use of plants to reduce maintenance costs dates from about 1930 when maintenance forces began planting mesembryanthemum or "iceplant" to reduce erosion, eliminate weeds and control fire.

What Functional Planting Does

Some of the things functional planting provides today are erosion control; delineation of route, of structures, of curves; center headlight screen; roadside screens to lessen noise, dust and headlight glare; ground cover for fire control and/or weed control; and screens for the benefit of adjacent development. Plants are used in great numbers on cut and fill slopes to control wind and water erosion. In many cases these functional plantings also beautify the road and blend it into or enhance the natural landscape.

In the 1920's, with the ever increasing number of automobiles, the important thing was to get the roads built. Because California's rugged terrain made thousands of cut and fill slopes necessary, these became a problem. Almost every Highway District had some sort of experimental program to control erosion. Fences, wattles, board baffles, rocks and asphalt were all tried.

Assembly Concurrent Resolution No. 132—Relative to State Highways

[Filed with Secretary of State, June 13, 1957.]

WHEREAS, The Legislature of California finds:

(a) In the last 10 years more than seven million dollars ($7,000,000) have been spent in planting on state highways, but this amounts to only six-tenths of 1 percent of total state highway construction expenditures of the same period; however, maintenance of this planting has cost more than eight million dollars ($8,000,000) in 10 years, and the annual cost is now approaching one million five hundred thousand dollars ($1,500,000) a year;

(b) Past policy of the Highway Commission has been directed purposely toward channeling a maximum amount of available funds into the construction of highway mileage that will provide immediate benefits to the traveling public;

(c) The Division of Highways under present policy undertakes two classes of construction work generally under the classification of planting, as follows:

i. Roadside development and control, which is constructed for the purpose of traffic control, economies of maintenance, or other engineering requirements. Within this class is included that work which may be required for erosion control, traffic safety, fire control, or traffic noise abatement;

ii. Landscaping, which is for the purpose of enhancing or preserving the aesthetic values of the highway and its immediate environs;

(d) Under present policy functional planting for roadside development and control is being done on a minimum basis consistent with actual requirements. Planting for landscaping is being done on freeways on a minimum basis, and almost exclusively in built-up or highly developed areas;

(e) Expenditures for landscaping and for design that enhances the attractiveness of highways are legitimate highway purposes for which the motor traveling public may properly be expected to pay;

(f) The appearance of freeways and other highways, and their design and landscaping in keeping with the immediate surroundings, especially in metropolitan areas, are major factors in their acceptance by the public in the affected communities;

(g) California's freeway development program can be greatly accelerated in the years ahead, largely as a result of the Federal-aid Highway Act of 1956, but such acceleration will depend in great measure on increased public acceptance which will be encouraged by attractive design and appropriate landscaping of freeways; now, therefore, be it

Resolved by the Assembly of the State of California, the Senate thereof concurring, As follows:

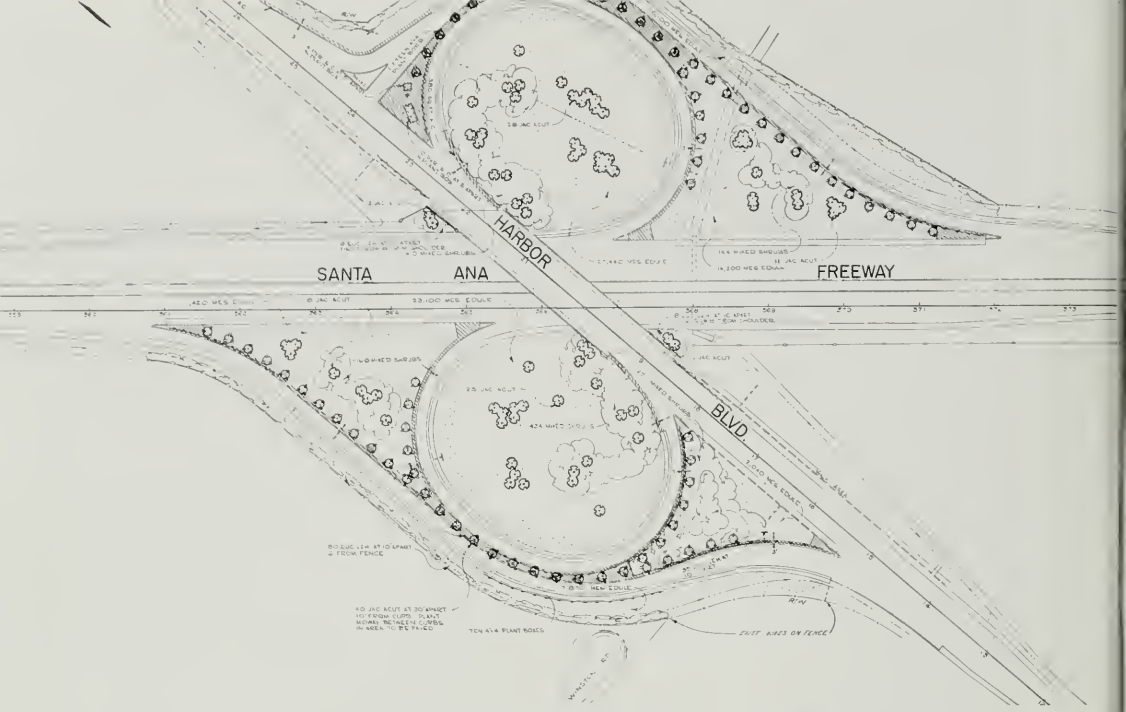
1. The California Highway Commission and the State Highway Engineer are commended for their past policies of economy in the matter of planting and landscaping;

2. In view of the expanded freeway development program now getting under way, the State Highway Commission is urged from this time on to give full consideration to functional planting and highway beautification in the formulation of its annual budgets for freeway construction and maintenance and local jurisdictions are encouraged to participate and cooperate in this program;

3. The State Highway Engineer is urged from this time on to give more attention to enhancement of the appearance of highways (particularly in metropolitan areas), not only by means of landscaping but also in the original design of structures and roadways. Wherever economically feasible under California's climatic conditions, consideration should be given to incorporation of parklike development in highway design;

4. The Department of Public Works is urged to portray at the earliest possible time in public hearings or on other appropriate occasions the nature of each proposed freeway design by means of artists' drawings or other visual aids in order to better inform the public as to the appearance of the freeway and its effect on the community;

5. It is the purpose of this resolution to inform the Highway Commission, the Department of Public Works, the State Highway Engineer, and the public generally, that the Legislature intends that a moderate increase in landscaping and other aspects of attractive design appropriate to conditions in this State be regarded as integral features of California's freeway program.



Typical planting plan for simple two-quadrant interchange on Santa Ana Freeway in Los Angeles. Plan calls for almost 75,000 iceplants, 250 jacaranda trees, 150 eucalyptus trees, and more than 1,500 shrubs.

One school of thought in the early days even advocated vertical cuts, claiming rain could not fall on such a cut. A few of these cuts were tried experimentally and actually were stable too, for a while, as long as the rainfall came down straight and did not continue too long. They failed quickly, however, in a driving rain or when erosion started from runoff water at the upper edge.

Slope Control Developed

Some of the techniques worked out by the U. S. Forest Service, the U. S. Soil Conservation Service, and the Bureau of Public Roads were incorporated into California's experiments, with encouraging results. Eventually a great deal was learned about slope control, and techniques developed in the 1930's are still used today.

In general, these techniques include carefully calculated and flatter angles, slope "benching", rounded crowns, and good drainage. The surfaces of the slopes are then held down with

Wherever possible, existing palms are used in planting plans. These were salvaged from right-of-way and transplanted.



plantings of grasses, vines and shrubs. Sometimes binding agents such as straw or a wood grid are used to hold the slope until the plant roots grow.

These slopes, of course, may be either on cut or fill sections. They are a greater problem today because "cut and fill" construction is used more than ever to get the straighter alignment, both vertically and horizontally, which is needed to provide safety at today's higher speeds.

"Landscaping"

The other kind of planting—"landscaping"—is understood to mean something more than functional planting. It includes planting which is purely for aesthetic reasons. Landscaping is considered wherever it is necessary to blend the right of way into adjacent development.

While this type of planting goes beyond function and strives for pleasing effects, nevertheless virtually all of it is also highly functional. It is planted for aesthetic reasons, but it also provides fire and weed control, delineation, headlight, noise and dust screens.

Sprinkling systems are usually installed in landscaped areas, to give a wider choice of plant materials. With more water, the plants grow better, and the over-all effect is greener, more lush. Because of the high cost of watering and maintenance, better landscaping can be accomplished when a cooperative agreement to cover these costs is made with the community. Such agreements allow much more latitude on design and choice of plants, and have resulted in some of the finest sections of landscaped freeway.

Billboard Control

Early in the days of freeway landscaping—(landscaped freeways were then called "parkways")—the Division of Highways found it was virtually useless to landscape without adequate zoning controls against billboards. Obviously, the purpose of beautiful landscaping may be defeated by excessive advertising display.

The current policy of the Division of Highways is set forth in a resolution adopted by the California Highway Commission on April 19, 1951, which is implemented by an order of the Director of Public Works issued June 21, 1951. Basically this order and resolution provides that no highway funds will be expended for landscaping of any section of freeway until the local governing body having jurisdiction has adopted proper ordinances prohibiting advertising displays "within view" of the freeway which is to be landscaped. This policy applies only to *landscaped* freeways, and certain minimum requirements as to regulatory ordinances have been



"Before and After" photos of freeway section of US 101 through San Luis Obispo to show effects of planting. Elapsed time between the two photographs was five years. Oleanders in median at lower left are later planting.





High retaining wall was necessary here on San Diego Freeway in Westwood Village, Los Angeles County, to save right-of-way costs. Planting was put in at request of Village Church. Creeping ivy eventually will cover entire wall.

worked out, which must be met before landscaping will be performed.

With the revision and adoption in 1953 of the Outdoor Advertising Act in its present form, the Director's order applies only to freeways within incorporated cities. The Outdoor Advertising Act controls the erection of advertising displays in unincorporated territory.

Advance Plan Study

All highway construction project plans are referred to the Supervising Landscape Architects office for recommendation concerning erosion control and planting before the plans are completed or the contract is advertised. This advance study often makes it possible to avoid maintenance problems which would be expensive.

For instance, these studies often recommend that construction contracts specify that the contractor must treat the slopes with straw. This is incorporated into the soil with a specially designed roller. It is essential the slopes get this straw treatment as soon as possible after completion and before rains occur, as one heavy rain can erode gulleys several feet deep in some soils.

After a highway construction job is completed, and the Highway Commission approves funds for a planting project, headquarters landscaping personnel study in minute detail the section to be planted. Several day's time is required on freeway sections, "field checking" every part of them, climbing slopes, studying local terrain, existing plant growth, exposures and soils. Planting jobs are let as separate contracts and many things must be considered before the specifications can be written.

Watering Most Important

The most important consideration is watering, as even the drought-hardy plants must be irrigated for several years before their root system is adequate to support them. Most urban landscaping jobs must be watered indefinitely. If for no other reason, the plants close to the traveled way must be washed off at least once each week to eliminate the greasy dust film generated by the fast moving traffic, which would eventually otherwise kill the plants.

Therefore the location of water outlets and permanent sprinklers is of major concern. Not only must they be placed so they leave no planted area unwatered, but they also must not wet private grounds beyond the right-of-way. Although it might seem adjacent property owners would welcome the free water, actually it would be a great nuisance, and highway sprinklers are set so they do not encroach. Obviously, they must not wet the pavement, either.

Apparently unrelated factors, such as prevailing winds and the foibles of motorists, must be considered in planning sprinkler systems. Where possible, the service outlets themselves are best located just over the edge of the fill, off the shoulder, to prevent their being broken off by wheels of vehicles, and to make the maintenance man's job safer. In planning the sprinkler system, the arcs and throws of the sprinklers must be fitted into the odd angles and curves of the freeway right-of-way as it progresses from interchange to interchange.

Choice of Plants

Choosing the kind of plants brings up a new set of problems. Since broken or dramatic effects divert the motorist's attention, it is best to use only a few varieties and create a smooth effect. But this is only part of the job. Plans must be considered for their effect visually, for their adaptability to local growing conditions, and for their ability to thrive close to moving traffic.

Will they do well on a south slope in this latitude? What about drainage? Is the soil acid or alkaline? Are the plants deep rooted to penetrate and hold the soil, or will they slide when the earth becomes saturated? What will be the character of the plants in the local climate—compact and bushy, or straggly? Can they be obtained in quantities?

Sometimes a hundred thousand shrubs and trees, and a half million ground cover cuttings are needed all at one time if several jobs are starting —more than all the commercial nurseries can provide on short notice. Nor can these demands be staggered, for most plantings must be made in summer before the soil is too wet to work. The new plantings then have the wet

winter in which to get established. A system of advance ordering and buying has been worked out to help handle the tremendous demands.

Plants Propagated Beforehand

The Division's Service and Supply Department is notified of the plant needs through a request form. A number of bids are obtained by the State Purchasing Division, and the plants are ordered in advance of delivery. The time between the date of the order and the date of delivery may be a few months or over a year, to give the supplying nursery a chance to propagate and/or collect the plants.

Delivery in such cases is normally made to one or the other of the two storage yards the Division of Highways maintains. One of these is located adjacent to the State Nursery at Davis, the other at the Clinton Street maintenance station located between the separated roadways of the Hollywood Freeway near Vermont Avenue in Los Angeles. Plants are cared for by Division of Highways landscape maintenance personnel during the time they are in the storage yards awaiting pick up by the various landscape contractors. The contractor gets these plants "state-furnished" and allows for these free plants in his bidding on the planting job. The contractor's effective date for beginning iceplant planting contracts is controlled by the specifications which do not permit planting until there has been sufficient rainfall to moisten the earth to a depth of at least one foot.

Ground Covers

Orders for ground covers, such as the ivy which has been very successful in the southern part of the state, are handled somewhat differently. These orders, which may run into as many as half a million plants for one job, specify holding the plants at the supplying nursery until needed, although the nursery is given a firm order well in advance. Often the contract specifies the contractor may, if he desires, take iceplant and vinca (periwinkle) plants from already well established plantings on state right of way, if he can do it without serious damage to the original planting.

The contractor is bound by a number of rigid stipulations. The plants must thrive. This requires him to water and care for them about four months after the actual planting is completed. He must clean up the area before and after planting. Specifications covering the use of commercial fertilizer, manure, and other soil conditioners must be followed. In addition he is bound by all the general provisions for contractors working of Department of Public Works contracts.

These are generalizations which pertain to all planting—both landscaping and functional. A number of other considerations enter into functional planting as such, although, as heretobefore stated, much of the so-called "landscape" planting is also essentially functional.

Median Screen Planting

Probably the functional planting most noted by the public is the planted median strip. The primary purpose of this center planting is to shield the driver's eyes at night from the tiring effect of the headlights of oncoming cars in the opposite lanes. Its secondary purpose is to diminish the speed of, or stop, cars crossing the median when out of control.

These cross-median accidents are relatively rare, but they may result in head-on collisions with fatalities if there is no barrier at all. A good



Fast growing acacias create lush effect in six years after planting on Santa Ana Freeway-Long Beach Freeway interchange, Los Angeles.



Prior to writing specifications on contract preliminary to call for bids, new sections to be planted must be carefully checked against plans.



Eucalyptus and California Tayon used for delineation at series of short bridges on US 40 just south of Davis.



Example of Type A slope control in Cahuenga Pass section of Hollywood Freeway.

median planting absorbs the shock, slows or stops a car which is out of control, and does not throw it back into the path of others. Of course, planting for this purpose is not always practical, and the Division has spent many thousands of dollars on experiments to develop other types of median barriers.

The shrub used for these median plantings must have many properties. It must grow densely to stop headlight glare, and retain its leaves the year round. It must grow in clumps, with many stems, be strong, neither brittle nor too willowy. It must not grow too high, nor change its character as it gets older—preferably it should grow in thick clumps between eight and ten feet high. It must be highly resistant to drought, and to the gases produced by automobiles. It must be able to survive in many kinds of soil, particularly in the heavy adobe soil found in many parts of California, through a wet, soggy winter. It should be ornamental, and it should be easily propagated so it can be obtained in great numbers cheaply.

Oleander Best for Purpose

No shrub has been found which will fit these requirements better than the oleander, (*Nerium oleander*), a member of the dogbane family, and native to the Mediterranean region. Although the oleander is widely used in home and park planting, occasional complaints are received because the Division of Highways is planting a "poisonous shrub." A few plantings are made inside freeway fences along frontage roads, but the greatest number by far are planted in the median. In any case, if either children or stock managed to get to the vicinity of the shrubs, they would be in much greater danger from traffic than from poisoning by the shrubs, the leaves of which are bitter and unpalatable.

The Division of Highways has no record of either people or stock ever being poisoned by its oleanders. Balanced against a very meager possibility must be the number of lives the shrub certainly has saved from death in traffic accidents.

Existing native sycomares on Pasodena Freeway were saved by building retaining walls to preserve natural grade around them.



Slope control is another major job of functional planting. It not only can save maintenance funds, but sometimes saves millions in right-of-way cost where property values are very high. Engineers must in these cases resort to steeper slopes on cuts and fills and use functional planting to help control the slopes from slipping.

Slope Stabilization

The landscaping section has three types of slope stabilization and in cases such as this "Type A" is justified. This type is for steep slopes, and is relatively expensive—$2 to $3 per square yard. Its basis is a grid of wood —2 x 4's vertically, 1 x 4's horizontally, with openings approximately a yard square. The framework is held in

place with stakes. The openings are filled with compacted top soil, then covered with six inches of straw. Finally wire mesh is laid over the whole and fastened to the grid. Ground cover is then planted in the soil beneath the mesh and straw.

Type A slope stabilization was first used on the Arroyo Seco Parkway (now the Pasadena Freeway) in the Los Angeles area. Although these slopes are quite steep (one to one), there have been no serious failures in more than 20 years. Much of the wooden part of the slope control has rotted out by now, but the plant roots have spread and matted so that the structural support is no longer needed.

Type B stabilization, commonly used on 1½ to 1 slopes, is similar to Type A, without the wooden grid. It costs about two-thirds as much as Type A, and is used wherever there is danger that the toe of slopes might slump and intrude on adjacent property or communications facilities.

Type C is used on 1½:1 or flatter slopes and consists of straw rolled into a cultivated surface and planted. If seed is used instead of plants the seeding is done before the straw is placed.



ABOVE. Young lady making iceplant cuttings on piecework basis for contractor who is planting freeway median nearby.

Ground Covers Useful

Ivies and iceplant are used in great quantities for these different slope and controls, and for control of weeds also. They are often used in both urban and rural areas as fire control cover, too, because they stay green and are not flammable. This is a far cry from the 1920's when maintenance crews burned the roadsides each year as the grass got dry and became a menace.

A number of hardy shrubs have been used for sound, dust, and headlight screens on the sides of urban freeways—several of the acacias, eucalypti, and California natives are used for these purposes with excellent results. The eucalypti also have proven to be one of the most useful trees for use in the arid sections, delineation of overcrossings, curves, bridges, and general screen planting.

These are all specific values obtained from planting. In addition there are the intangible values obtained, the softening and increased interest given the roadside area—both functional and beautifying. With between 25,000 and 50,000 trees planted each year, and between 100,000 and 200,000 shrubs, the Division of Highways more than compensates for those which must be removed for straightening or realigning the routes. This fact is often overlooked when critics complain of tree destruction. It also is important to remember there are practical financial ceilings on landscaping which can be raised only by added taxation or by reducing expenditures for highway modernization.

(The next article on California Roadsides will discuss the problems of maintenance.)



Photo of contractor's crew planting interchange on Hollywood Freeway Extension in North Hollywood gives good idea of scope of planting jobs. Small circles are wetted planting holes with newly planted shrubs. Dots are empty gallon cans.

BELOW. Contractor's crew and equipment planting iceplant cuttings in median, Santa Ana Freeway, near Tustin.



Paver Control

Experimental Device Used In Resurfacing Operations

By W. H. CRAWFORD, District Construction Engineer



On the District VIII "thin blanket" project to resurface existing pavement with asphalt concrete at various locations in San Bernardino and Riverside Counties, an automatic grade control device attached to a paver was used experimentally. The device was used at three locations.

This particular project, which provides for a one-inch surface course over existing low standard pavement, was chosen for the experimental use of the electronic control to observe the operational characteristics of the device on a pavement surface of irregular grade and cross section. Although the contract plans provided surfacing material for advance leveling of major pavement failures and building up of curve superelevations, the existing pavement after such treatment could not be considered as comparable in smoothness to a regulation leveling course of asphaltic concrete over prepared subgrade. The type of surfacing operation was, therefore, considered to be ideal to test the operation of the automatic paver control on worse than average conditions, and also to determine if improved grade and cross section of surfacing could be obtained without exceeding quantity limitations.

Operation Explained

To better understand how the device functions a review of the main characteristics of the paver's floating-type screed follows:

The tractor unit tows the screed assembly by the two draft arms. The weight of the screen structure is, however, supported solely by the paved surface. In effect, the screed rides on that surface in a manner similar to a water skier.

There exists some equilibrium angle of attack at which forces on the screed are in balance and the pavement thickness remains constant. To increase thickness, angle of attack of screen relative to draft arm is increased by means of the hand-operated screw. Then the screed rises as the machine goes forward until the equilibrium thickness is again reached. Thereafter, the thickness is constant at its increased value.

The screed structure is torsionally flexible so that the two sides act almost independently. Thus, a tapered mat can be laid by maintaining different screed-to-draft-arm angles on the two sides. Generally, one man is able to adequately control both sides, but present-day tolerances on almost all types of work sometimes necessitate having a full-time screed man on each side. This is particularly true on resurfacing work where the grade and transverse slopes of the existing pavement are almost never smooth, so that variable paving thickness is often required to remove base roughness.

Prevents Breaks

The floating screed principle assures that, under normal conditions, abrupt breaks cannot occur in the paved surface. That principle, combined with a moderately long tractor wheel base, tends to cause the paver to produce a smooth surface in the direction of travel if the base roughness is of wave length less than 20 feet or so.

Theory and practice show that roughness is reduced by approximately one-half in each succeeding layer of surfacing. For longer wave length base undulations, the mat tends to be of constant thickness and the base undulations appear in the final result. On normal roads and streets, four or more mats are required to span the width; usually the outside mats are laid first. The outside screed man will then attempt to control his end of the screed to properly match an existing concrete gutter or other structure. The inside screed man has no guide except for periodic measurements of mat thickness.

The task of the screed man is made more difficult by another aspect of the floating screed principle; namely, that a change in the screed adjustment produces no immediate effect on the mat thickness. Thus, there is a time or distance delay of 10 to 15 feet interposed between the need for a correction and achievement of the correction. The screed man must look ahead and try to anticipate what adjustment is required. Over-controlling of the screed is a common fault, and desired accuracy is not always achieved on a manually controlled paver.

From the preceding description of the paver employing the floating screed principle, it can be readily seen that it will inherently tend to lay a smooth mat; however, the degree of smoothness obtained is to a great extent limited by the skill of the screed man.

Follows Grade

The experimental paver control employs a grade following system on one end of the screed and a transverse slope control which will cause the other end of the screed to follow the first, thereby maintaining a constant preset transverse slope on the paved surface. Photographs of the experimental control as installed are shown in Figures 1, 2, 3 and 4. Drive motors indicated as "Left Drive Motor" and "Right Drive Motor" are connected to respective screed adjusting screws to allow automatic operation. The grade follower arrangement can be transferred from one side to the other to suit job conditions. Transverse control is accomplished on the opposite side.

The follower shown in Figure 2, consisting of a steel bar ½" x 4" x 30'-0" with a rigid 10-foot center section, was used in the experiment to assist in establishing grade control for

the first mat placed, usually the right lane. This 30-foot semi-rigid follower, to the center of which the follower arm was attached, was passed over the existing pavement, resting on the high spots and bridging the low spots to a considerable extent. The flexible ends were designed to deflect sufficiently to conform to the radii of the many short vertical curves encountered on this project.

Figure 3 shows the follower used to pick up grade for the adjacent mat for the left lane. This follower, or ski, was a short section of ½" x 4" steel bar attached to the follower arm. Note that this follower rides on the top of the mat already in place and compacted.

Arm Extends Forward

Anticipatory action, which is difficult for the screed man to accomplish manually, is obtained on the grade follower side by having the follower arm extend forward toward the draft arm to union center. In effect, the control will cause the screed to automatically follow the same path it would take if the base on which the paver runs were absolutely parallel to the selected grade reference surface. That end of the screed thus becomes independent of the tractor elevation and base roughness.

Proper anticipation is needed on the other end of the screed also, because the pendulum, being mounted on the screed, will not immediately respond to the adjustments of the second screed screw. However, when the second screw is driven in response to an error signal from the transverse slope control system, a change in screed twist angle will occur. This angle is measured by a potentiometer, and the resulting electrical signal is used to oppose the pendulum signals, thus stopping the second screed motor at the proper time.

Mat is Placed First

At locations on this contract where the control device was used, the traveled way consists predominantly of two 12-foot lanes with variable width shoulders. The mat for the right-hand lane was placed first, with the paver traveling in the direction of traffic for that lane. All traffic was carried

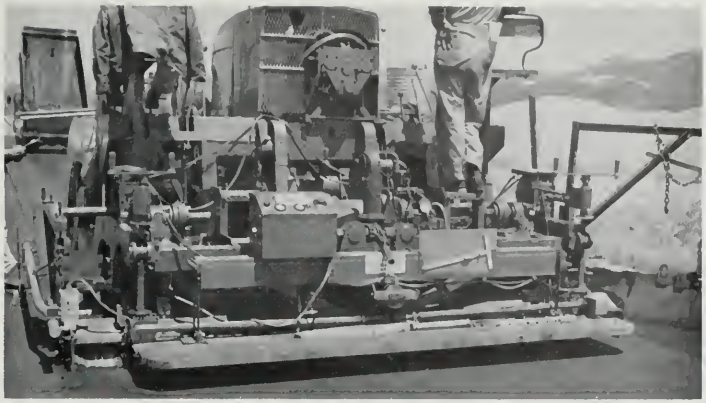


FIGURE 1. Rear view of paver showing transverse beam which supports pendulum and control equipment.



FIGURE 2. View of left side of paver showing follower arm and 30-foot skid in place. Grade control is obtained from bottom edge of skid which travels over surface of existing pavement or subgrade.



FIGURE 3. View of left side of paver showing follower arm and metal ski in operation. Note that ski travels on surface of completed adjacent mat.

through construction on the other half of the roadbed.

For the laying of this first mat, the grade follower (in this case, the 30-foot steel bar) was run directly on the existing pavement a few inches to the left of the centerline traffic stripe. The zero adjustment was set to spread material one inch compacted above the bottom edge of the grade follower. The outside end of the screed was under automatic transverse slope control with the slope dial set at the required slope. The transverse slope was determined in advance by checking the existing pavement ahead of the paver with a slope board.

Due to irregularities in the grade and cross section of the existing pavement and to the quantity limitations imposed by the job specifications, it was necessary to slightly vary the slope every few hundred feet to fit conditions. The slope setting was changed as required while the paver was in motion. One screed man performed this operation and other duties about the screed with ease.

The mat for the opposing lane was laid in a similar manner, in that the paver operated in the direction of traffic. The grade follower for this run was a short metal skid that traveled directly along the inside edge of the compacted mat for the first lane, with the zero adjustment set to spread material slightly above the pavement edge to allow for compaction. As before, the outside end of the screed was under automatic transverse slope control.

Results Compared

At one location, a portion was resurfaced in the conventional manner with the paving machine under manual control, and on another portion the grade control of the paver was handled automatically with the control device. Conditions were favorable on this stretch of highway to observe not only the operational characteristics of the automatic control but to compare results obtained by use of the automatic control with results obtained by use of conventional control.

The above two-mile stretch of highway is an old two-lane road originally constructed some thirty years ago. It is characterized by curved alignment with an undulating grade line closely following the natural terrain. There are ten horizontal curves and 37 vertical curves irregularly spaced throughout the two-mile stretch. The pavement generally was in poor condition, containing many cracks, patches, and edge failures. The transverse slope of the pavement was also very irregular with excessive crown at the quarter point and inadequate superelevation at the curves. The riding qualities were practically the same throughout the two-mile trial section.

The general appearance of the resurfacing placed by automatic control is slightly better than surfacing placed by manual grade control. There is a noticeable lack of patched areas or evidence of corrective work. The transverse slope of the pavement is also more uniform where the automatic control was used. As a uniform transverse slope tends to use more material when resurfacing old high-crowned roads, the slope was varied as necessary to remain within mat thickness limitations. Slopes for several hundred feet in advance were predetermined and the screed man made the necessary adjustments with ease as required. The use of a near uniform transverse slope added materially to the riding qualities of this test section, and also improved riding qualities at locations on other routes where the automatic control also was used.

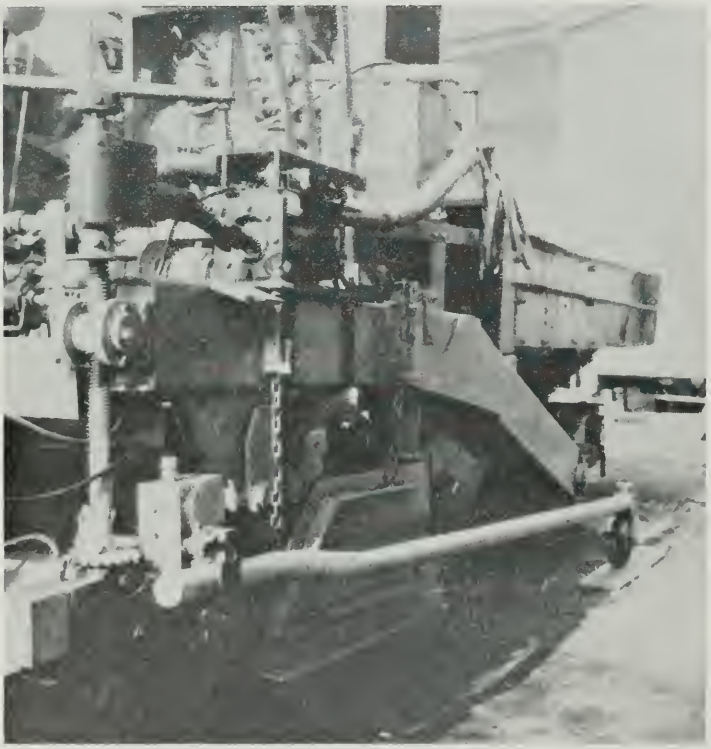


FIGURE 4. View of right side of paver with follower arm in place. Skid or spline is used instead of wheel depending on job conditions. Note electric motor on draft arm and gear box, beneath screed screw handle.

Joints Are Matched

Another feature of resurfacing that is materially improved by use of the automatic control is the joint between adjacent or opposing mats. The automatic control, by picking up electronically the grade of the adjacent compacted mat by means of a grade

follower riding directly on the edge of the adjacent mat, assures that the correct amount of material will be placed to provide a perfectly matched and smooth-riding joint.

Based on observed results of the experimental use of the electronic control on portions of this contract, it can be said that the device, when employed, shows promise of greatly improving the operation of a floating screed paver. Its usefulness to control pavement grade over a prepared subgrade should prove to be even more marked than was demonstrated on this resurfacing job.

The observed benefits to be derived from use of the automatic control appear to be as follows:

1. Provides positive grade and slope control, thereby removing the guess work from anticipatory screed manipulation.
2. Improves riding qualities of asphalt concrete pavement.
3. Tends to eliminate corrective work at edges and center joint.
4. Simplifies duties of screed man and eliminates need for two screed men on difficult work.

The electronic control device used on this project is an experimental model. When production models become available a full scale evaluation will be made to determine the effect on all types of asphalt concrete paving operations.



View of left side and back of paver with electronic grade control in operation. Follower arm with ski picking up grade from adjacent mat. Note perfect grade of uncompacted mat slightly high to allow for compaction.



View of paver and grade control attachments. Follower arm and 30-foot metal straight edge in operation. Note that straight edge does not interfere with operation of other equipment.



Close up view of follower arm and rigid center portion of 30-foot straight edge.

NEW U.S. 399 ROUTING

The California Highway Commission has adopted a freeway routing for the relocation of 7.6 miles of U.S. Highway 399 in Kern County between 2.25 miles northeast of Valley West Road and 0.2 mile east of State Highway Route 139 (Enos Lane).

The adopted route cuts easterly across a north-stop loop which the present highway makes west of the Kern River. East of the river the adopted route follows the existing highway.

The U.S. Bureau of Public Roads has estimated total travel in the United States for 1960 to be 720 billion vehicle miles, a three percent increase over the previous year.

Salinas Valley

New U.S. 101 Freeway Sections Bring Traffic Relief to Area

By A. M. NASH, District Engineer



WITH THE successful competion of a six-mile expressway between Soledad and Gonzales and a three-mile freeway bypassing the city of Soledad, nine miles of a modern, safe traffic artery have been added to U. S. 101 as it flows through the heart of the rich, fertile Salinas Valley, often referred to as the Salad Bowl of the United States.

Construction is now well under way on the freeway bypass of Greenfield. Construction of the Gonzales freeway bypass is imminent. With completion of these last two projects we shall be able to provide a full four-lane divided highway artery to adequately serve all traffic needs on U. S. 101 between Salinas and King City, a distance of 48 miles without a single stop sign in between.

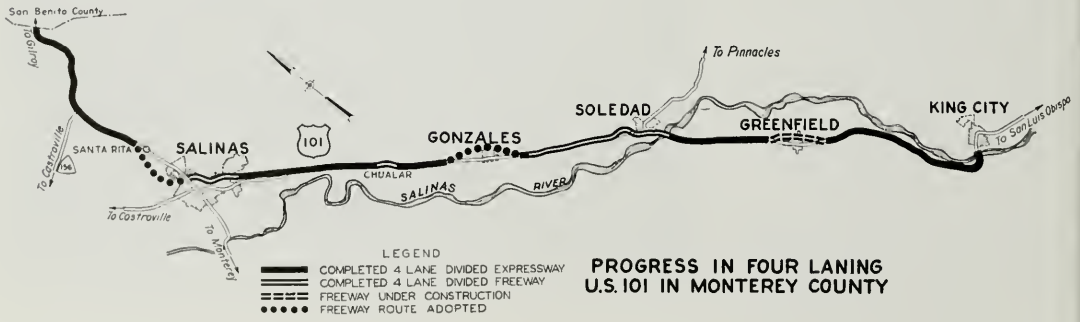
The traveling public has already experienced the beneficial effects of the expressway between Soledad and Gonzales which was opened to the public last December eleventh.

Congestion Wos Problem

This project was originated to eliminate the traffic deficiencies restulting from the increasing volume of traffic using the route, coupled with congestion caused by large vegetable pro-



The interchange south of Soledad and just north of the Salinas River. The old highway (right) goes under the railroad.





Spanning the Salinas River south of Soledad with a twin to the existing bridge. The Arroyo Seco overhead between Soledad and Greenfield is visible (center background).



Piling shown in place for twin structures over the railroad and old highway (front center). The Soledad Bypass and Salinas River are in the background.

duce trucks operating during harvest season. This last factor naturally led to considerable unsafe use of shoulders for passing purposes, often at excessive speeds.

Our expressway location parallels the previously existing highway and is slightly easterly thereof, we were able to utilize approximately 60 per cent of the old highway as southbound lanes with the remainder used as frontage roads. The old highway was naturally resurfaced and brought up to the latest highway construction standards before the expressway was completely opened to public use.

With the exception of a 1.2-mile section nearest Gonzales, the project was constructed to freeway standards with full access control and necessary grade separation structures. The remaining 1.2-mile section was constructed to expressway standards with two crossings of the expressway at grade level. This section will be converted to full freeway standards with necessary grade separation structures and frontage roads as part of the Gonzales freeway bypass project.

Two Structures Built

Two overcrossings were constructed over the divided freeway. One, a four-span concrete girder bridge, 683 feet long, provides access to the State Correctional Facility approximately halfway between Soledad and Gonzales. A second, nearly identical structure, the Camphora Overcrossing near Soledade, provides easy access to many adjacent vegetable farms and dairy ranches.

The surrounding land within the limits of the project is relatively flat and drainage is critical. Although the average rainfall is only 10 inches, the surrounding fields are subject to heavy irrigation. The combination of rainfall and irrigation runoff over level land has flooded the old highway at several locations at varying times of the year. This condition has been corrected by placing new culverts and by locating the lanes above the runoff flood plane. Reinforced concrete



US 101 through the City of Soledad showing congestion typical of past years before construction of the freeway bypass.

pipe was used under the new lanes exclusively and was selected because of its high hydraulic efficiency on the flat grades with which we were confronted.

This $1,610,000 project, contracted to John Delphia and Fred J. Early, Jr., is now completed. Dan Connolly was Resident Engineer, and W. H. Schooler, represented the Bridge Department.

Work on Second Project

This same team, with Dale Williams replacing Schooler as Bridge Department representative, also worked together on the Soledad freeway bypass project directly adjoining the above project at its southerly terminus. The other end of this three-mile freeway project connects to a divided four-lane expressway between Greenfield and the Salinas River south of Soledad which was completed in 1958. Completion of the Soledad bypass, therefore, immediately provides traffic with an uninterrupted divided four-lane highway between Greenfield and Gonzales, certainly a significant achievement in itself.

The south end of the Soledad bypass freeway begins 0.3 mile south of the Salinas River. The existing highway for 3,000 feet, including the existing bridge over the Salinas River, is being utilized as northbound lanes on the new freeway. A new bridge paralleling the existing structure has 13 spans of 104 feet each and two shorter spans for a total length of over 1,500 feet, which closely approximates the length of the existing bridge. To add to the similarity, barrier type railing will be installed on both old and new structures.

Route Veers West

Continuing northerly, the new alignment veers to the west just south of the existing highway-railway underpass. A traffic interchange has been constructed at this point to provide adequate access to the city of Soledad, easy access to the freeway for motorists traveling south from Soledad and facilitates access to a frontage road west of the freeway which serves neighboring farms and ranches.

Paralleling the railroad and the westerly Soledad city limits the freeway continues directly north, turning east to cross the railroad approximately 0.3 mile north of town. Here four-span parallel bridge structures are necessary as the new route crosses both the Southern Pacific Railroad and the existing highway which will remain in use as access to Soledad from the north. Each of the bridge structures is of composite girder type utilizing steel girders and bonded concrete decks, and are over 300 feet in length. Twenty-eight foot roadways and steel railings are provided at both of these structures and at the separation structure south of Soledad.

Interest is Created

The use of asphaltic base and asphaltic concrete has created considerable additional interest in this project

among construction and materials specialists. A cross section of the roadways shows 24 inches of new construction, including 11 inches of imported borrow, 6 inches of untreated rock base, 3 inches of asphaltic concrete base, 2 inches of asphalt concrete leveling course 1½ inches of dense graded asphaltic concrete with a cover of ½ inch of open graded asphaltic concrete. Nearly 40,000 tons of asphalt mix using nine different sizes of aggregate was used. The contractor initially had considerable trouble with this material as his hot plant and paving machine were not designed to handle large aggregate up to 2½ inch maximum size. However, experience led to relatively minor adjustments in the contractor's machinery which enabled successful efficient completion of both hot plant and paving operations.

Deflection tests were taken on various levels of construction beginning with the layer of untreated base material. Permeability tests were taken on all three layers of the asphaltic concrete pavement as construction progressed. Data from these tests will be of considerable assistance in reaching conclusions as to durability of the pavement and the entire project should serve as a fair test of these construction materials and methods.

Two-way traffic was routed onto the northbound lanes of this project last July with an immediate noticeable decrease in traffic congestion through the city of Soledad. With the opening of the entire freeway to full traffic use next October, this entire central Salinas Valley area will be free from traffic congestion for the first time in many years.

SIGN ROUTE 4

The California Highway Commission has adopted a freeway routing for 10.7 miles of State Sign Route 4 (Ebbetts Pass Highway) in Calaveras County between Camp Connell and Ganns.

The adopted route generally follows or closely parallels the existing highway, but eliminates sharp curves and excessive grades.

Stanford U. Starts Highway History Collection



We are inclined to think of test roads, such as the one recently constructed and operated by the American Association of State Highway Officials in Illinois (See page 47, January-February, 1961, issue of this magazine), as of recent vintage. However, among the material already submitted to the Western Highway Historical Collection being formed by the Stanford University libraries is this photo of an early test road near Pittsburg, California, circa 1925. (Photo by Charles W. Geiger)

The founding of an historical collection, covering the early days of highway transportation in the Western States, has been announced by the Stanford University libraries.

The project will be carried on in cooperation with motor carrier associations in 13 Western States, the provincial associations in Alberta, Saskatchewan and British Columbia, and the Western Highway Institute.

Items being sought for the collection include photographs and documents, such as tariffs, copies of operating authorities, interchange agreements, labor contracts, payrolls, house organs and the personal recollections of pioneer carriers and suppliers.

All donations will be carefully preserved by the University for use by future scholars "wishing to recapture the events of a remarkable period in the history of transportation."

Contributions will be acknowledged and the names of donors will be suitably recorded with book plates.

Communications should be addressed to Western Highway Historical Collection, Stanford University Libraries, Stanford, California. It is requested that special care be taken by donors to identify properly names, places and events.

Interstate Estimate Nears 2½ Billion Dollars

The cost of completing California's 2,182-mile portion of the National System of Interstate and Defense Highways is estimated at $2,458,512,000, according to a report to Congress by the Secretary of Commerce in January.

This is a considerably larger total than that of any other state, and reflects California's heavy motor vehicle registration and mounting traffic needs.

California's apportionment factor for the next four fiscal years (1963-66), based on the new Interstate needs estimate, is 9.656. In other words, California will receive 9.656 per cent of the total national Interstate apportionment for each of the four years.

In another report from the Department of Commerce, California's progress on the Interstate System was shown to be far ahead of the other states, in terms of funds expended or obligated on completed, current, or authorized projects.

The quarterly report of the Bureau of Public Roads for December 31, 1960, showed that California had expended $556,100,000 for construction, engineering and rights of way on projects completed in the first four and a half years of the accelerated highway program. Going contracts or authorized projects accounted for an additional $539,700,000. The figures include both State and Federal funds.

Flood Problems

State, Local Agencies Cooperate In Improving Highway Drainage

By T. E. FERNEAU, Assistant District Engineer and
H. C. SUENDERMAN, District Hydraulics Engineer



After World War II, when State highway construction was actively resumed, California Highway Engineers found that drainage was becoming a serious and costly problem, quite different from earlier days when highway drainage consisted mainly of bridging major stream channels, placing a culvert in the gulches and small creeks, and allowing pavement runoff to flow over the side.

The population of California was increasing at an amazing rate and land values were jumping upward to unthought-of heights and then continuing their upward trend. Wastelands previously allowed to receive excess storm and flood waters were now being reclaimed, so that concentrated discharge of excess storm waters on them could no longer be tolerated. Also, vast areas of impervious surfaces were created, as farm lands became residential subdivisions. As a result, existing drainage facilities became overtaxed. The need became clearly evident for close cooperation between the Division of Highways and local agencies in the planning and construction of more adequate drainage systems, on and off the highway right of way.



The Napa Cooperative Drainage Project looking downstream from the junction of the collector channels at the railroad trestle and double bridge under Sign Route 29.

Drainage Group Formed

In 1948 District IV, which includes nine counties in the San Francisco Bay area, concluded that drainage problems were of sufficient complexity and importance to warrant the development of a small group of specialized engineers whose primary duties would concern highway drainage and disposal of storm runoff with least detrimental effect to the highway and to adjacent private property. The Hydraulics Section was formed and is now headed by a Senior Highway Engineer with title of District Hydraulics Engineer.

The functions of this section are to design major drainage facilities for State Highway projects; advise highway designers concerning general surface drainage and check designs prepared by others; furnish rainfall-runoff information; make continuous checks of changes in land use for drainage changes as they may affect State Highways, make special studies of drainage problems for Maintenance, Right of Way, Construction or other departments; and to analyze and make recommendation for disposition of claims and complaints involving drainage.

The primary goal of any State highway drainage facility is to prevent water from collecting on the highway and to retain, insofar as practical, the natural drainage pattern as it exists at the time of construction. Protection of the State highway, while preserving the existing drainage pattern, is not always possible to achieve by construction of drainage facilities within the highway right of way. Under these circumstances the Hydraulics Section must take the initiative in designing a satisfactory inlet and outlet channel, and in obtaining the cooperation of the appropriate local agency in the acquisition of rights of way for, and construction of, such channel.

Subject to Regulation

The fact that expenditure of State Highway Funds is subject to certain constitutional and statutory restrictions, as well as careful budgeting, in-

troduces further complications. Particularly with respect to work outside the right of way, there must not only be a clear showing of benefit to the State highway, but also that the proposed expenditure of State funds does not exceed the amount of this benefit. This requires financial participation by the local agency, which is sometimes difficult to obtain because of its budgetary or other restrictions.

After mutual problems have been worked out a "Cooperative Agreement" is executed, whereby one of the parties does the work, subject to a financial contribution by the other or in the alternative, the State does the work within the highway rights of way and the local agency the work outside, with each agency paying its own costs.

In the design and construction of new freeway and highway projects, co-operation with city, county and flood control agencies has also made it possible to arrange highway drainage systems so that they conform to local master drainage plans. The drainage facilities thus installed for the State highway will therefore not generally require expensive modification or replacement at a later date. The overall result is a saving in public funds which would otherwise have been spent had the Division of Highways and some local agency acted unilaterally in providing their respective drainage facilities. In some cases, in which a change in drainage pattern was the best solution, the local agencies have provided the necessary right of way across private property and constructed the required channel and storm drain outfalls.

Local Interests Pay

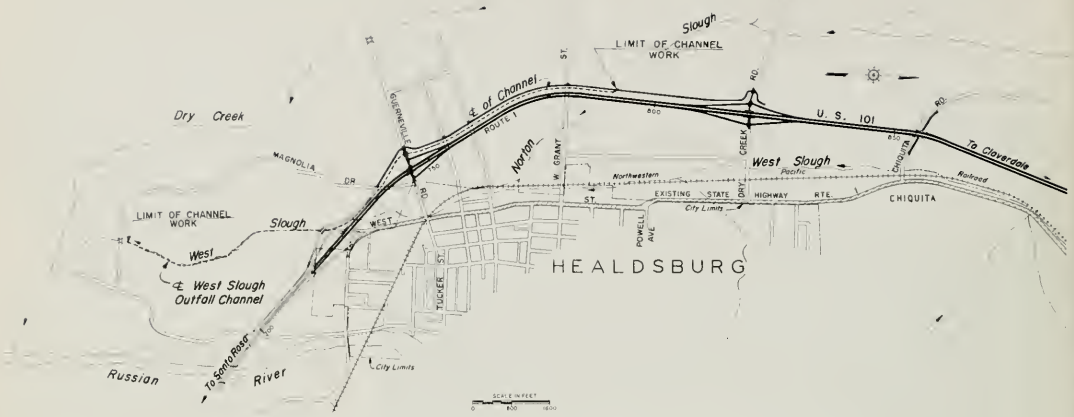
There have also been instances where storm drain, sanitary sewer and utility crossings of local public agencies have been paid for by local interests but included in the highway construction contract, thus effecting a saving to the public by eliminating the excessive additional costs, and inconvenience to the public involved in constructing a future utility installation across a completed freeway carrying a large amount of traffic.

A notable case of this nature was in the design and construction of the Nimitz (Eastshore) Freeway, between Hayward and San Jose. The close co-ordination and co-operation between the Alameda County Flood Control and Water Conservation District and the Division of Highways resulted in adjustment of location of a number of the proposed freeway drainage structures at no additional cost so as to conform with the Flood Control District's area-wide drainage plan. Inlet and outfall channels were constructed by the Flood Control District to insure proper functioning of the freeway drainage structures.

At various locations drainage improvement projects by local agencies were necessitated by urbanization of tributary watersheds. Many of these improvements involved increasing the capacities of existing natural drainageways. At some crossings of existing State highways, present drainage structures have been in existence for many years and lack the capacity to accommodate the increased drainage resulting from changes in land use. In those instances where it was concluded that provision for increased capacity at the highway was a State



IV-NAP.-49-B
SALVADOR ZONE
OF THE
NAPA COUNTY FLOOD CONTROL AND
WATER CONSERVATION DISTRICT



A map of Healdsburg and vicinity shawing the highway and drainage areas discussed in this article.

obligation, construction of an adequate size structure was financed by Highway funds. By means of co-operative agreements, the State portion of the work was co-ordinated and combined with the local agencies' project so that the project was constructed under a single contract with resultant saving in public funds.

Co-ordinotion Important

A typical example of this situation was that where the Alameda County Flood Control and Water Conservation District constructed a drainage improvement in the vicinity of Newark. By co-operative agreement adequate replacement of the existing old and undersized culvert across State Highway Route 107 was paid for by the State but included in the Flood Control project, thus insuring proper co-ordination of the work and eliminating the necessity of a separate contract for the portion determined to be a State obligation.

During the past four years approximately 300 improvement projects of various kinds and varying degrees of magnitude have been undertaken through the co-operative agreement procedure between the Division of Highways and local public agencies within the nine counties in District IV. Fifty-two of these projects have resulted in solving drainage problems with direct and indirect benefits to all concerned. Evaluation of the past few years' experience in this District shows evidence that many flood and drainage deficiency problems, which have been magnified by rapid and extensive urbanization, can be solved when all agencies involved accept their responsibilities and co-ordinate their efforts. The response of local political bodies to this idea has been enthusiastic and gratifying.

The direct benefits have been savings of public funds at both the State and local levels and the accomplishment of needed drainage improvements long before these improvements could have been done by individual agency financing. Some, in fact, might never have been accomplished without co-operative action.

The indirect benefits have been increased land values and higher land use potential for lands previously subject to periodic flooding, the mental relief and thankfulness of local residents as well as State highways users no longer subject to flood hazards, and the growing idea in public agencies that more is accomplished by co-operation than by "going it alone." It may be that the indirect benefits transcend the direct in the broad view.

NAPA CO-OPERATIVE DRAINAGE PROJECT

By W. C. McDONALD,
Associate Highway Engineer

During 1957, a 2.3-mile section of State Sign Route 29 in the County of Napa from Union Station to Orchard Avenue was expanded from a two lane highway to a four lane expressway under Contract 58-4TC3. A drainage system was constructed under this contract which included 6,500 lineal feet of longitudinal collector channel and 8,600 lineal feet of outfall channel, as a co-operative project with the County of Napa.

Topography in vicinity of the project is shown on the accompanying map. The main drainage for the area is the Napa River, located easterly from and approximately parallel to the highway, which drains southerly. Terrain adjacent to the highway generally slopes gently to the east although the highway actually traverses a broad shallow swale within the limits of the improvement as shown by contours. West of the highway there is a range of hills, and drainage from these hill watersheds crosses the highway location to outfall in the Napa River.

Prior to improvement there was a longitudinal ditch between the highway and the single track Southern Pacific Railroad which was adjacent to the highway on the west. The ditch was about 8,000 feet in length and was fed by several ditches or channels which crossed the railroad via culverts or trestles and which drained the land west of the highway. The longitudial ditch drained north and south to the low area in the vicinity of El Centro Avenue. In the low area there were three stone arch culverts, two with spans of 8 feet and one with a span of 6 feet which passed drainage across the highway. These culverts were distributed through a length along the roadway of about 1500 feet and were drained by two outfall channels to the Napa River.

Deficient in Capacity

The longitudinal ditch and outfall channels were deficient in capacity. During heavy rains the longitudial ditch would run bank full, with overflow water sheeting across the pavement. In the low area water would back up to submerge the pavement, and would occasionally cause the road to be closed to traffic for a period of hours.

Project report studies were made during 1953 and one phase of the study was the consideration of possible alternate methods for improving the unsatisfactory drainage condition.

These studies determined that there was insufficient space between the railroad and the existing highway for a ditch with adequate capacity. A ditch in this location would encroach on existing pavement and preclude its use for the southbound lanes of the proposed expressway. If the longitudinal ditch was to be preserved and if flooding of the pavement was to be eliminated, the ditch would have to be located either on the upstream side of the railroad or on the downstream side of the improved highway. In addition to these two alternates, an alternate was considered which would eliminate the longitudinal ditch by the construction of several outfall channels.

It appeared that only one of the three alternates considered could be done by the Division of Highways without participation by the County of Napa, and that was the alternate which proposed a longitudinal ditch to be constructed on the downstream side of the proposed expressway. This alternate would have provided a longitudinal ditch with capacity equivalent to the then existing ditch and would have eliminated flooding of highway pavement but would not have eliminated flooding of adjoining land. The drainage condition of land adjoining the highway would not have been changed.

Alternates Require Co-operation

Both the other two alternates required extensive outfill channel improvements which were considered to be beyond the province of the Division of Highways. It appeared that these alternates would require cooperation by the County of Napa to acquire right of way, to share in the cost and to be responsible for changed drainage conditions and for continuing maintenance for portions of the system outside State's right of way.

During the Project Report studies the drainage problems were discussed with the County Engineer and Road Commissioner. It developed that no improvements were then designed or contemplated for construction, but that it had been determined that the ultimate drainage system should retain the longitudinal ditch and that a single outfall channel should be developed approximately along the line of one of the two then existing outfall channels. Also, while no improvements were then contemplated, the need and justification for improvements were increasing as a result of continuing changes in land use from agricultural to residential.

The proposed expressway had a large requirement for imported borrow for fill material. Thus considerable channel excavation could be justified in conjunction with the proposed project since this would provide an economical source of fill material, provided the material produced would be usable. Accordingly, a materials survey as well as a topographic survey was then made of proposed channel sites.

In discussion with the County Engineer it was agreed that the longitudinal or collector channel and outfall channel should be designed to



Looking downstream at the outfall channel from the frontage road on the east side of Sign Route 29 in the Napa area.



Looking south of the beginning of the Norton Slough channel change. The freeway is shown (left) and the frontage road (right). The flow of water to the slough on the other side of the freeway is controlled by the 24-inch pipe partly visible above the water in the reinforced embankment to the left.

have capacity for a once in 15 year recurrence runoff with freeboard. Freeboard was provided for the 15 year runoff so that the channels would contain a once in 50 year recurrence runoff with a bank full stage. Design flows were estimated on the basis of the Rational Formula using a runoff coefficient of 45% which was considered to represent the area as it would be in its ultimate state of development. Trapezoidal sections were proposed with side slopes of 1½ :1 and sections were proposed to be as broad as possible in order to facilitate construction.

Surveys Are Completed

During 1954, the surveys were completed and a drainage system was designed which included a longitudinal or collector channel, an outfall channel and a single culvert under the proposed highway. The culvert proposed was a double 12′ x 7′ x 140′ R.C. Box and was designed to pass the once in 100 year runoff from the drainage area in its anticipated ultimate condition of development. The proposed culvert was positioned directly downstream from an existing trestle under the railroad with total gross span of 45 feet. The proposed longitudinal collector channel was positioned to be adjacent to and west or upstream from the railroad. The design included a determination of channel excavation and highway fill quantities so that an economic study could be made of the proposal that channel excavation be used for proposed highway fill in lieu of pit produced material, the materials survey having demonstrated that the material produced from channel excavation would satisfy specifications for highway fill. Right of way requirements for all proposed channel work were also determined.

On December 14, 1954, at a meeting of the Board of Supervisors, the District presented the proposed design with the purpose of acquainting the county officials with the detail of the proposals. The Supervisors were informed that the Division of Highways could co-operate in the proposed project to the extent of benefits derived. The County was requested to determine whether or not the proposal was feasible from the standpoint of the County's ability to assume costs and other obligations which were in excess of those which the State could assume.

Drainage Zone Formed

The Board then instructed the County Engineer to proceed with necessary steps required to form a drainage zone for special assessment, to be known as Salvadore Zone. Costs and obligations which would accrue to the County would be borne in part by the proposed zone and in part by the Napa Flood Control and Water Conservation District as a whole. Costs of necessary hydraulic structures on County roads would be charged to a special fund which existed and was known as the Special Road Improvement Fund of the County of Napa.

Early in 1955, the proposed co-operative project was presented to Headquarters Office and in April of 1955 the District was authorized to enter an agreement with the County

. . . Continued on page 76

4-Level Interchange

New U.S. 101-395 Connection Is Under Way in San Diego

By D. S. SHEPARD, Senior Highway Engineer



THERE is an age-old adage that "you can't have your cake and eat it." Also, there is the old saw that "there are exceptions to every rule." An apparent exception to this adage is the four-level interchange construction project located in the southern section of Balboa Park in San Diego. For here is a project where various levels of government, federal, state and city, plus the private citizen, can have their cake and eat it too.

This is the result of close liaison between the State and the City, together with engineering aimed at preserving and enhancing the Park's existing beauty, whereby the public will gain a much-needed freeway and simultaneously acquire greater useful areas of park lands. By the filling and leveling of several canyons with more than a third of a million cubic yards of earth, more than 50 acres of usable land for recreation and parking areas, outside of the highway right of way, will be created.

Previous Use

Of the total park lands needed for the freeway development, 9.3 acres were previously devoted to existing roads, 14 acres were occupied for non-park uses such as the U.S. Naval Hospital and the San Diego Children's Home, and 4.4 acres were utilized for parking lots. There were 25.7 acres of steep slopes upon which landscaping will be vastly improved and 17 acres of flat- to moderately-sloped park lands.

In summary, 17 acres of usable park area will be replaced by 50 acres suitable for development to the highest and best park use.

Needless to say, the movement of substantial quantities of roadway excavation is entailed in this operation. The moving of one million cubic yards of roadway excavation on a job not quite one-half-mile long is now nearing completion on the four-level interchange.

Of this quantity, one-half was moved across a four-lane freeway without a moment's delay to the traveling public. This was accomplished by making use of an existing overcrossing bridge. The terms of the contract permit hauling across the bridge with off-highway equipment, provided the equipment travels in a proper path with respect to the bridge girders. Under the contract, after hauling of excess dirt was completed, the bridge had to be demolished and removed.

Bridge is Used

The advantage of hauling over this bridge became apparent to the contractor (R. S. Hazard Contracting Co. and W. F. Maxwell) on the adjoining project, as he had to haul to a disposal site that was on the opposite side of the 4-level project from his work. Therefore an agreement was reached with the contractor on the 4-level job (Daley Corporation & R. M. Price Construction Co.) to use the same bridge. This agreement was of definite benefit to the public as it eliminated the trucking of an additional 150,000 cubic yards of material over city streets. The bridge shows no signs of distress although at times there were over 1,000 trips a day with loaded equipment (of up to 70 tons).

The Cabrillo Freeway traffic of 43,000 vehicles per day was handled by the construction of a detour that allowed the traffic to move without obstruction. This created a secondary



The four-level interchange under construction in San Diego showing the temporary haul bridge over the Cabrillo Freeway. The view is westward.



Looking east over the construction site of the four-level interchange in San Diego. Naval Hospital in background.



Interchange construction, looking southeast toward the Ford Building in Balboa Park.

problem when work was being done immediately adjacent to the traveled way. The regular freeway speed was too fast for safety, and normal 25 M.P.H. work zoning proved almost unenforceable. A permanent reduction was undesirable as the speed restriction was only needed during working hours. An intermittent-type control was adopted. Speed zone signs (40 MPH) were erected at each end of the project and lockable covers were provided. Thus, each work day the signs are locked open in the morning and locked closed at night. The local police department is much in favor of the system and the public seems to be accepting it.

Columns Erected

At the present time the contract is over one-third completed with the earth work virtually finished. The way is now open for the bridge work; and the present sprinkling of columns is expected to change into a forest in the near future. Completion of the structures alone in the 4-level complex will require 18,000 cubic yards of concrete laced with more than 4 million pounds of reinforcing steel.

Included in this 18,000 cubic yards of concrete is 4,715 cubic yards of lightweight concrete. The use of lightweight concrete is relatively new to highway construction and is being used here to reduce the dead load on the top level of the four-level interchange. This reduction in dead load allows the use of smaller girders on this 70-foot-high bridge. It also produces a not-readily apparent savings in the construction costs.

This use of lightweight aggregates in the concrete of the upper portions of the one bridge reduced the load on its footings by more than 2,500 tons. By reducing the load on the footings, their size in turn could be reduced. This reduction of footing size obviously reduced the area of excavation needed. The fact that some of the footings were more than 20 feet below the ground surface indicates the savings of excavation involved.

Because the elevation of the top deck was controlled by the maximum permissible grades on the San Diego Freeway (U.S. 101), the real savings were in reducing the roadway excava-



Some of the palm trees salvaged during construction operations.

tion that would have been involved in lowering the level of U.S. 395 at the bottom to accommodate the necessary vertical clearances at all levels.

Storm Drains in Operation

The majority of the more than $385,000 worth of storm drains are in and working, including one drain made up of 1852 feet of 84″ reinforced concrete pipe, 1124 feet of 90″ RCP, and 836 feet of 96″ RCP. The base and paving portion are just beginning, with only two short sections of portland cement concrete pavement placed.

A landscaping project is scheduled to start immediately upon completion of the present highway contract, about mid-1962. This project will necessitate expenditures of more than a quarter of a million dollars and will be designed to blend with the existing Park plantings. The result will be a parkway terminated by the 4-level structure itself as a frame for the entrance into downtown San Diego.

All of the slopes within the interchange area are being contour graded to facilitate the landscaping. Approximately 25 palm trees were salvaged during the clearing and grubbing operation for this project (see *California Highways* magazine for Sept.-Oct. 1960).

Completion of the interchange, together with its re-landscaping, will every day provide thousands of local and visiting motorists a refreshing view of nature's beauties as they travel through the area on either U.S. 101 or U.S. 395.

It may safely be prophesied that Cabrillo Freeway's claim to the "most beautiful freeway" title will be seriously threatened by the portion of the "San Diego Freeway" that borders beautiful Balboa Park along its southerly side.

Double White Lines To Be Made Yellow

Almost all double white lines on California highways will be painted yellow within the coming year.

The change is part of a nationwide program to provide uniform highway markings conforming with the U.S. Bureau of Public Roads revised manual on traffic control devices.

The new federal manual eliminates the double white line as a permissible alternate to yellow lines for separating opposing traffic on multi-lane highways.

California has used the double white line for more than 20 years. The color will be changed on highways throughout the state as the present white lines need repainting due to weather and traffic wear.

Yellow lines will be used to designate no-passing zones where traffic is not separated by any physical barrier or else is separated only by raised traffic bars. Yellow lines will also be used to channel merging traffic and to mark railroad crossings.

School crosswalks and warning markings will continue to be marked in yellow, in accordance with State law.

Another revision of the federal manual calls for a change in California's green and white signs which are used to indicate service and rest areas and roadside businesses. In the future, such signs will be easily identified by their white reflectorized message set in a blue opaque background.

SIGN ROUTE 16

The State Division of Highways has opened bids to reconstruct 2.3 miles of State Sign Route 16 between 0.4 mile west of the junction with State Sign Route 104 and 1.4 miles southwest of Plymouth in Amador County, to provide the initial two lanes of a future four-lane expressway. Low bidder was Claude C. Wood Co., Lodi, $328,924.

Projects on FAS County Roads are planned and in most cases constructed under the direct supervision of the county involved. They are financed out of federal allocations, state matching money and county funds when required.

Driver Training

Departmental Program Covers Testing of 13,300 Employees

By B. A. SWITZER, Safety Engineer

On December 16, 1959, Governor Edmund G. Brown ordered into effect the recommendations of his Inter-Departmental Safety Advisory Committee whose report proposed an intensification of accident prevention by defensive driver training and further control methods.

The recommendations of the Governor's Accident Prevention Committee basically set up two proposals for improving the driving record of State employees: 1. Driver Training, and 2. Driver Review.

Driver Training was to be provided for all employees who even occasionally drove a State car. Training to be complete for present employees by June 30, 1961. The Driver Review was to be instigated and also operating by that time. Provision was to be made for training of new employees and retraining of old employees where review indicated such course was desirable.

Training Program

The program of Driver Training in the Department of Public Works requires that approximately 13,300 employees be provided with instruction, including lectures, testing, and road observation runs. The administration of this activity was assigned to the Safety Section in the Division of Highways.

The State Personnel Board, through the Safety Coordinator's Office, developed a manual and course for Driver Training considered adequate under the recommendations of the Advisory Committee. Selected employees were given training that was offered by the State Personnel Board under their program.

Due to the many different operations condtions under which the Department of Public Works is required to function, it was decided that a course should be developed that would be pointed toward their particular problems and responsibilities.

A Driver Training Manual was developed incorporating a part of the information developed by the Safety Coordinator's Office of the State Personnel Board and other information considered appropriate to our problems and conditions.

The lecture is designed to provide information to encourage drivers to develop in theirselves an attitude of accident prevention based on defensive driving methods, rules, and regulations.

Best Safety Records

It has been found that drivers with physical limitations often have the best safety records. Investigation indicates that these people recognize and compensate for their deficiencies. In line with this broadly accepted knowledge of driver adaptability to their limitations, psychophysical testing equipment was obtained to test and indicate to the employee if he has any physical or eye restrictions of which he should be conscious, and compensate for.

Peripheral vision is tested. (Safe driving requires a wide side vision.) Color blindness is checked. Visual acuity is determined. Also the ability of the driver to judge distances and clearances is determined by this special equipment.

An electric reaction timer is provided to determine and illustrate the time required to actually react to an outside stimulant. This is transferred into distance by appropriate tables.

Driver training in the Division also requires a road test or observation run. The employee drives over a pre-

Assistant Safety Engineer Ralph W. Zook Dies

Ralph W. Zook, Assistant Safety Engineer for the Division of Highways in Sacramento, died of a heart attack at Redding on February 15 where he had gone to conduct safe driver tests among Division employees.



RALPH W. ZOOK

Zook was in charge of the Division's driver training program for Central and Northern California. A large number of employees in the Department of Public Works had come to know him as the soft-spoken man who conducted them through their driving tests under the department-wide driver improvement program inaugurated last year.

He had been in safety work since 1954 when he moved to Sacramento from Bakersfield where he had been a Maintenance Superintendent. He joined the Division in 1941.

Zook was born in Gainsville, Arkansas where he went to grade school. He came to California in 1922 and attended high school in Glendale, later studying at Glendale College and Bakersfield Junior College.

From 1933 to 1941 he was employed on construction of the Los Angeles Aqueduct.

He was known to hundreds of boys and their parents in Sacramento where he was active in the training and managing of Little League and Babe Ruth League ball clubs. A fine chess player, he was acquainted with many leading players in the State.

He was a member of the Masons, the Scottish Rite, Elks and Sierra Club; and the American Society of Safety Engineers and the Public Relations Round Table of Sacramento.

He is survived by his wife, Anna May, a teacher; daughters, Mrs. Darrell Forney, and Cynthia; and son, Bill, all of Sacramento.

scribed course with an observer noting his driving habits and discussing with him those habits, both good and bad, that effect his driving and calling to his attention those habits which need to be changed to improve his driving.

Originally the program was developed for classes of approximately 30 employees which would be given the lecture, the psychophysical tests, and the road test. Later it was found desirable in Sacramento and District Headquarters to modify the program and give the lecture to large groups of 80 to 200 and call them back on a scheduled basis for the psychophysical testing and road observation run.

Every effort is made to obtain participation in the lecture portion by employees so as to answer questions and obtain a clear understanding on the part of all participants in the objectives of the program.

Assumes Certain Skills

The Driver Improvement Program does not attempt to teach employees to drive, it being assumed that they already are skilled in the standard driving techniques and possess a California drivers license. The purpose of the program is to develop defensive driving techniques and review and discuss the legal and moral responsibilities of an employee when driving a state-owned automobile.

A government survey of the six-year driving records of nearly 30,000 motorists indicated that 85% of the accidents are distributed among the vast majority of drivers—people like ourselves who have had occasional near-misses, or once in a lifetime, a serious accident. If all accident repeaters were removed from the highway, the study indicated, the total number of accidents would be reduced less than 4%. A study by the California Department of Motor Vehicles indicated that over one-half of the serious accidents involve drivers who haven't had an accident in the past 20 years.

Knowledge of traffic laws and regulations, manipulative skills and so-called psychophysical abilities do not indicate safe or unsafe drivers. In fact, an unsafe driver may excel in all of these functions. It becomes then a matter of mental attitude and knowledge of modern defensive driver techniques as to whether a driver handles his car safely or not.



Carroll T. Berry, Assistant Safety Engineer, talks to a group of Department of Public Works employees in Los Angeles taking the driver training course. The employees are also given driver reaction tests and taken out in a car to observe their driving habits.

Drivers Are Surprise

Even experienced drivers are surprised when they discover how far their car travels while they are taking their foot off the accelerator and hitting the brake in an emergency stop. Accidents occasioned by following too closely are one of the serious problems in modern traffic conditions and one where the knowledge of distance travelled in the stopping time available is particularly important.

In our driver program, we use a motion picture called the "Smith Method of Defensive Driving." This picture stresses and illustrates the importance of the following five items:

1. Aim high in steering.
2. Get the big picture.
3. Keep your eyes moving.
4. Leave yourself an "out."
5. Make sure you are seen.

The objective of defensive driving is to protect your car and passengers from damage and injuries. A defensive driver is defined as one who is careful to commit no driving errors himself, who makes allowances for the lack of skill or improper attitude on the part of others, and who does not allow hazards of weather and road conditions or the actions of pedestrians and other drivers to involve him in accidents.

He keeps continually on the alert, and recognizes an accident-producing situation far enough in advance to prevent a serious accident.

A defensive driver takes no unfair advantage of the mistakes of others. He is willing to take every safe driving precaution and, if necessary, help make up for the other driver's mistakes and discourtesies. He anticipates the actions of others and develops a mental attitude that every person, animal, or vehicle can be a potential hazard and might take an unexpected course of action. He endeavors at all times to maintain a cushion of protective space around his car.

Right of Way Problem

A defensive driver is conscious of the fact that the Vehicle Code does not give the right of way to anyone

at anytime, but merely provides that under certain conditions one driver must yield the right of way to another. A State driver should always relinquish the right of way rather than to continue on and try to force the other driver to yield, by the threat of collision.

The driver training program calls to the attention of each State employee that when he is driving a State car, he represents the entire State of California and anyone seeing the insignia on the side of the vehicle or the Diamond E license plates looks to such a motorist to be an exemplary driver and expects him to set an example of defensive and courteous driving.

State vehicles are not expected to be driven with obviously defective controls. If the brakes are defective, they should be corrected immediately. If there are other conditions unsatisfactory for the operation of the vehicle, it must be called to the attention of the proper person.

If Carbon Monoxide is found to be leaking into the car, the state driver is taught to take the following steps:

1. Pull vehicle over to the shoulder.
2. Stop the car.
3. Turn off the motor.
4. Set the brakes.
5. Finally open the windows.

If there is Carbon Monoxide, it is not unlikely that the driver will blackout when the fresh air hits him. That is the reason that the car should be stopped before the windows are opened.

Seat belts are provided in all State vehicles. State drivers, by executive order, are required to use them. Our files are filled with specific examples of seat belts preventing injury in case of accidents.

The Cornell studies on seat belts show that you are 60% less likely to have an injury and are 50% less likely to be killed if you are using seat belts when involved in an accident. The study also indicates that you are five times more likely to be killed if you are thrown out of your car than if you remain in the car and are held in place with a seat belt.

Driver Review

The California program of prevention of accidents to State-owned vehicles involves a review of the Driver Records as well as the Driver Training Program. The Department of Motor Vehicles has found a direct correlation between the number of citations and the number of accidents in a driver's record. A number of citations can be regarded as an indication of a problem driver. Careful review of accident reports and conviction records with drivers is found to improve driving habits.

Our program now calls for all new employees to have a report from the California Department of Motor Vehicles (Form DLMU-122) covering their driving record before they are permitted to use a State car. This form is also obtained and reviewed when a driver obtains a citation from the California Highway Patrol for violations when in a State car.

The Division of Highways maintains a record of all motor vehicle accidents and the employee who is responsible. When an employee is found to have been involved in several accidents, his driving record is reviewed, and if necessary, the matter is called to the attention of his supervisor and the man is subject to counselling by a representative of the Division or even by a representative of the Department of Motor Vehicles.

Men Are Assigned

In order to obtain uniformity and continuity in the program in the Department of Public Works, three representatives, Ralph Zook, Frank Fournier, and Caroll Berry were assigned portions of the State and conferred with the Safety Supervisors and others conducting the Driver Training Program in their respective Districts.

So effective has been their handling of the situation that they and the District's representatives have frequently been called upon to speak to public gatherings and other Departments relative to the Driver Program.

As of January 1, the complete program had been given to approximately 10,000 Public Worker employees.

In the early phases of the program a questionnaire was passed out in one of the Districts where the program was underway to obtain suggestions for improvement of the presentation of the program. The principal comments indicated desirability to use more motion pictures. We have, therefore, standardized on the film known as the "Smith System of Defensive Driving" distributed by the Ford Motor Company and a film on safety through "Seat Belts" produced by the Institute of Transportation and Traffic Engineers at the University of California at Los Angeles. Some variation in presentation of the program is permitted to the instructors to meet local conditions.

The driver training and improvement program is expected to further reduce the recordable accident record of the Division of Highways which has been lowered so far from a frequency of 1.38 per million vehicle miles in 1950 to 0.70 in 1960.

Santa Clara County Votes Road Program

On March 28, the voters of Santa Clara County approved a $70,000,000, eight-year highway construction program, climaxing 4½ years of cooperative work and study. The program will be financed by 25-year general obligation bonds and is the first phase of an eventual $225,000,000 long-range project to improve the County's highway system.

The completed system will consist of eight expressways — four-lane, divided high capacity highways on which access will be carefully limited and controlled. The entire network is designed to feed traffic to and from state routes as well as unite the various areas and cities of the county.

Those cities which will not have portions of the expressways within their boundaries will still receive at least 70 percent of the money raised by its citizens for other approved road construction, the allotment formular being based on assessed valuation.

Santa Clara County is the second fastest growing county in the state, being exceeded only by Orange County.

The county and city governments in 1957 joined with the state in financing a $230,000 study of overall traffic needs.

J.H.D. No. 9

33-Year-Old Cooperative Program To Improve Sign Route 1 Concluded

On February 3, 1961, the directors of Joint Highway District No 9, an organization which has spent almost 33 years developing the Cabrillo Highway along the coast of San Francisco, San Mateo and Santa Cruz Counties, held its final meeting in San Francisco.

At this meeting, which took place at the District Office of the Division of Highways, checks for $244,600, the contribution from Joint Highway District No. 9 on the final project, were presented to the State. The Joint Highway District directors, representing the respective member counties, were Leo Halley, President (San Francisco); Mrs. Hulda McLean, Vice President (Santa Cruz); Alvin Hatch, Treasurer (San Mateo); and Errol V. Rosenthal, Secretary.

Receiving the check for the State was Director of Public Works Robert B. Bradford accompanied by T. F. Bagshaw, Assistant Director, and J. P. Sinclair, Assistant State Highway Engineer. Upon receiving a certificate of completion from Mr. Bradford, the directors adopted a resolution dissolving the District.

Joint Highway District No. 9 was created by the Boards of Supervisors of the three counties in 1928. The 1917 Joint Highway District Act of the California Legislature permitted organization of such districts throughout the state by two or more counties where the proposed highways were in the public interest, and set up procedures for contributing state funds to the projects. Other funds required were to be provided by the District from assessments on the member counties.

Resolution is Adopted

Proceedings for formation of the District were initiated by the Santa Cruz County Board of Supervisors by resolution adopted on May 7, 1927. The primary purpose of the District, construction of a two-lane highway connecting Santa Cruz and San Francisco along the coast, has now been accomplished.

The Ocean Shore Highway, originally decribed as "commencing within the County of San Cruz at a point of connection with a main public highway already existing and extending northerly as closely as practicable to the shoreline of the Pacific Ocean, through the County of San Mateo, and into the County of San Francisco, to a suitable point connecting with a main highway within said County," is now referred to as the Cabrillo Highway.

Subsequent to the organization of the District, the Legislature in 1933 designated the general route of the Ocean Shore Highway as State Highway Route 56. As a consequence, most of the construction was performed under State controls with the Joint Highway District contributing toward the financing.

The District Board of Directors estimated the cost of constructing the highway to be $5,300,000 at the time the District was created, and proposed that the cost be apportioned between the three counties to derive the major benefit from the construction of the highway. The assessments ratio recently in effect provides apportionment of the cost as follows:

San Francisco County	55%
San Mateo County	31⅓%
Santa Cruz County	13⅓%

Collections of this assessment from the three member counties since the time of the district formation, to and including the final assessment for the period ending June 30, 1961, total $3,883,000 (San Francisco $2,135,400, San Mateo $1,223,900 and Santa Cruz $523,700).



A simple bookkeeping transaction marked the successful completion of a 33-year cooperative project to construct and modernize 68 miles of State Sign Route 1 between San Francisco and Santa Cruz. Supervisor James Leo Halley of San Francisco (center), president of the Board of Directors of Joint Highway District No. 9, is shown handing the district's final payment for its share of the work to State Director of Public Works Robert B. Bradford. The other two members of the board are Mrs. Hulda McLean, vice-president, Santa Cruz County supervisor; and Alvin Hatch, treasurer, San Mateo County supervisor. At right is Errol V. Rosenthall of San Francisco, secretary.



The Half Moon Bay Bypass (left) looking north from the junction with the original Coast Highway south of Half Moon Bay.



Construction between Whitehouse and New Years Creek on Sign Route 1, the final project to receive a contribution from Joint Highway District No. 9.

Relief Funds Used

In addition to the contributions from the three member counties, approximately $300,000 in Federal Emergency Relief Funds and the allocation of state highway funds enabled the completion of the highway at a cost of near $12,000,000, excluding maintenance and minor improvement expense. Expenditures for construction totaled $9,200,000; for rights of way $2,080,000; for preliminary engineering $730,000.

The first project was completed in 1935—1.4 miles between Skyline Boulevard and Junipero Serra Boulevard at Daly City, and 3.6 miles southerly along the cost to Edgemar in 1935 and 1936—financed entirely from state highway funds at a cost of about $144,000 each.

Subsequent projects were financed jointly by the District and State, with the exception of a one-mile section of highway just south of Davenport and several minor drainage and repaving projects, financed by the State.

The last Joint Highway District project between New Years Creek and Whitehouse Creek in San Mateo County, was completed in December, 1960. This 2.1 mile project was financed by $244,600 from the District and $200,000 from state highway funds.

A total of 28 contracts have been completed in the development of the Ocean Shore Highway (now known variously as the Coast Highway, State Sign Route 1, and the Cabrillo Highway) for a distance of 68.1 miles, 50.3 miles in San Mateo County and 17.8 miles in Santa Cruz County.

U.S. 66 RELOCATION

The California Highway Commission has adopted a freeway routing for the relocation of 3.1 miles of U.S. Highway 66 in San Bernardino County east of Needles.

The adopted route begins 3.1 miles west of the Colorado River and extends to the river opposite Topock, Arizona. It is on a more direct line than the present highway, which makes a loop to the north.

Los Laureles Grade

New Road Saves Time, Distance

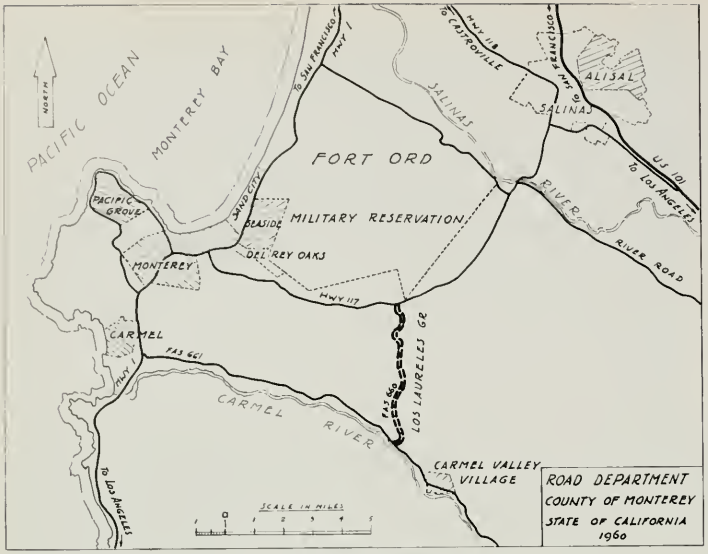
By BRUCE W. McCLAIN, Road Commissioner, Monterey County

Before reconstruction of the Los Laureles Grade Road, most commuters travelling to or from Carmel Valley shunned the slow hazardous trail encountered on the "Grade" and drove a greater distance of 17 miles by way of Monterey from "The Village" to Salinas. The new Los Laureles Grade Road (Federal Aid Secondary Route No. 660), now provides not only a savings in time and distance for the daily commuter, but also a scenic view of much of the lower Salinas Valley from the Ridge summits. It extends from the Monterey-Salinas Highway (State Route No. 117), on the north to the Carmel Valley Road (Federal Aid Secondary Route No. 661), on the south—a distance of 6 miles; and provides a direct link over the Sierra de Salinas ridge of the Santa Lucia Range between Carmel Valley and the greater Salinas Valley.

The old Laureles Trail predated the turn of the century and the prevalence of the automobile by many years. As a horse and buggy way, it doubtless sat-



The Los Laureles Grade project, located east of Carmel and Monterey was constructed under the Federal Aid Secondary highway program and replaced a curving mountain road (sections visible in the center of the above photo) with a modern, two-lane highway. The old road has been renamed Toro Road. The view is south.



A map showing the location of the Los Laureles Grade project (double dotted lines) described in the article.

isfied all criteria and standards of its day. But time and progress have a relentless way of changing things and notions. Even the superior of its day, in time, sloughs in to obsolescence, and a secure and commonplace routine then becomes, with the modes of tomorrow, a tortuous adventure. And so it was with "the old Grade"; it had many curves proven safe only at speeds of less than 10 miles per hour, and sight distances of just about total blindness. The 14 to 16 foot wide road surface consisted of oil on native soil. Maintenance costs were excessive due to the absence of imported base material and to the lack of adequate drainage.

Conditions Corrected

In the reconstruction of the road these substandard conditions were corrected to meet minimum design standards for rural County highways as adopted by the County Engineers Association of California.

The Los Laureles Grade relocation project was laid out and designed by the Monterey County Road Department from aerial contour maps produced by stereoscopic interpretation of aerial photography using triangulated ground control points. The aerial survey was carried out in February, 1955, and the completed maps were delivered to the County the following April. The Road Department made no preliminary ground survey for this project. It was the first Monterey County Highway project to be laid out and designed completely from aerial contour maps.

The relocated Los Laureles Grade was built in four FAS projects, since available funds were limited. Each project was laid out so that construction began and ended on the then existing old road; in this way each section became an independent construction unit, and the entire length of any of the first three segments could be utilized singly or collectively. Traffic counts were made after each section was completed as a check for the expected increase in daily traffic as reconstruction and realignment progressed. This provided the warrant for the next segment in the overall program.

Joint Supervision

Construction of the new Laureles was under the joint supervision of engineers of the State Division of Highways and the County of Monterey, and was spread over a period of 4½ years. Construction on the first project was started November 27, 1955, and the last section was completed April 14, 1960.

The first two projects of the program involved grading and temporary surfacing of 5¼ miles of the roadway. The roadbed was built to a width varying from 36 feet to 44 feet with two 12-foot traffic lanes. Minimum allowable curve radius was 250 feet



BEFORE. A section of the Los Laureles Grade road token in 1956.



AFTER. The same section following completian af the project.



BEFORE. This photo, also taken in 1956, shows another section of the old road.



AFTER. The same section taken shortly after it was reconstructed.

and maximum grade was limited to 10 percent.

Project 1 construction involved 2¼ miles of new road extending from a point 0.7 mile north of the Carmel Valley Road to the summit of the old Los Laureles Grade. Project 2 construction extended the first from the old summit through to a new summit to State Route 117 on the Salinas Valley end. The new alignment increased the summit elevation by approximately 90 feet. To eliminate the need for excessive grading, the new road was aligned to follow the ridge top, dividing the Carmel River drainage basin from that of the Salinas River, for 0.6 mile before descending on sweeping curves to join the old Los Laureles Grade just north of its junction with Robley Road. The new alignment shortened the length of the road in the first and second sections by approximately ¾ of a mile. The increase in elevation between the old and the new summit, and the shortening of the road produced a maximum grade steeper than that of the old road. The increase in grade, however, is not critical since ther are no ice conditions and heavy trucking seldom uses this route.

Sections Are Paved

Project 3 construction involved paving parts of the 1st and 2nd projects with 2 inches of plant mix surfacing after 6″ of imported base material was first placed over portions of the previously sealcoated surface. The last 0.4 mile of road south of Route 117 has not been paved since the coarse seal surface of this section appears to be holding up well. The total length of the 3rd project was approximately 4 miles.

The 4th project consisted of the following: Constructing a new road with plant mix surfacing on imported base material for the first 0.85 mile north of the Carmel Valley Road; realigning the first 0.15 mile of the 1st section to eliminate three short curves of sharp radii; and paving 0.65 mile of the existing roadway built under the first project construction.

The Los Laureles Grade project was made possible, in part, by anti-recession funds in the Federal-Aid Highway Act of 1958 and by normal Federal aid to Secondary Road Systems, California State Matching Funds and Monterey County Funds, as follows:

COST BREAKDOWN

	Project 1	Project 2	Project 3	Project 4	Total
FAS	$106,500	$139,600	$132,713	$77,712	$456,525
State	48,373	96,466	12,836	55,488	213,163
County*	41,299	16,950	60,260	21,942	140,451
Totals	$196,172	$253,016	$205,809	$155,142	$810,139

* Includes preliminary and construction engineering costs.

Warrant for the Los Laureles Grade was clearly indicated from the immediate jump in daily traffic after completion of the first stage of the new road. In 1955 the average daily traffic on the Salinas side of the grade was 200 cars per day. After completion of the first project of the program, a Monterey County traffic survey made in July of 1956 indicated that traffic had increased to 580 cars per day. In May, 1960, just after completion of the last project, a traffic count of 980 cars per day was evidenced. It is expected from statistics of the past 4 years of population increases in Carmel Valley and the experienced increase in traffic over Los Laureles Grade, that an anticipated population of 20,000 in the Valley by 1980 may well generate a daily traffic which will approach 5,000 cars per day.

The County of Monterey, its Board of Supervisors, the Road Commissioner and his staff commended W. S. Dolliver, former city and Cooperative Projects Engineer for the Division of Highways in San Luis Obispo, for his untiring efforts in implementing the project which led to its ultimate approval, financing and final construction. Dolliver retired last June after 33 years as an engineer with the State.

S.M.-Hayward Bridge Mole Job Is Awarded

The State Department of Public Works has awarded a contract for construction of a mole fill at the eastern approach to the San Mateo-Hayward Bridge, to Piombo Construction Company, San Carlos, $642,820.

The fill, which will project about 0.2 mile into the waters of San Francisco Bay, will be the future location of the toll plaza for the bridge. The toll plaza is now located on the San Mateo side, but will be relocated to the Hayward side in connection with the proposed widening of the bridge from two lanes to four.

The California Highway Commission at its March meeting approved five projects on Federal Aid Secondary County Roads with a total estimated cost of $1,055,000.

I.T.T.E.

Continued from page 39 . . .

works; Ben T. Ostergren, of the American Road Builders Association, Washington, D. C.; and Arnold H. Carver, chief communications engineer for the Division of Highways.

Richard H. Ward, Redding city engineer; George Webb, traffic engineer for the Division of Highways; Gerald Skiles, Los Angeles senior traffic engineer; Dan Finch of the ITTE; John W. McDonald and G. P. Parmelee of the Automobile Club of Southern California; Robert W. Graver, of the California State Automobile Association; Richard Bartle of Stone and Youngberg, San Francisco; and Joseph B. Hughes, Madera County road commissioner.

California Hosts Civil Defense Meet

The public works aspects of civil defense will be the subject of a five-state seminar to be held in Sacramento May 9, 10, and 11, it was announced by State Director of Public Works Robert B. Bradford.

Bradford said that Governor Edmund G. Brown had agreed to have California act as host state for the seminar, in accordance with a request from the Office of Civil Defense Mobilization.

The first of four such seminars to be held this year throughout the United States, the California seminar will be attended by governmental officials and other specialists from Arizona, California, Hawaii, Nevada, and Utah.

Representatives will be present from the Office of Civil and Defense Mobilization, Bureau of Public Roads, and the Army Corps of Engineers. Business, labor, and the general contracting industry also will be represented.

Problems to be discussed are the organization and administration of federal, state and local public works services during an emergency; how to provide for demolition, shoring, and debris clearance; how to temporarily restore community facilities and services, and how to decontaminate essential resources and areas.

LAB PHOTO WINS PRIZE AT PHILADELPHIA EXHIBIT



The above crash test photo was taken by Robert M. Souza of the Materials and Research Department to illustrate why it is necessary to isolate anchorages used for chain link barrier fences. It was awarded second prize in the black and white "technique" section at the American Society for Testing Materials Biennial Photographic Exhibit held in Philadelphia. The photo was taken by Souza with a Hulcher 70 mm sequence camera from the top of a 30-foot aluminum tower. Souza suffered minor injuries during a previous test when the tower was knocked over by a runaway bus.

U.O.P. Holds 4th Annual Highway Conference

The Fourth Annual Highway Conference at the University of the Pacific was held March 7-9 in Stockton.

Speakers at the luncheon sessions on the UOP campus were Dr. Robert E. Burns, university president; Ellis Armstrong, president of the Better Highways Information Foundation; and Dexter D. MacBride, assistant chief right of way agent for the Division of Highways.

Sixteen papers were presented, followed by group discussions, covering various technical problems and research projects. A panel discussion on city and county road financing was also featured.

A reinforced concrete bridge will be constructed over the Bear River on Federal Aid Secondary County Road 922 (Pleasant Grove Road) about four miles northeast of Rio Oso in Sutter County.

Bridge Costs

1960 Survey Shows Continued Decline

By H. K. MAUZY, Senior Bridge Engineer and
W. J. YUSAVAGE, Associate Research Technician

The downward trend of bridge construction costs which began in the summer of 1957 continued on through 1960. During this period the Bridge Department Construction Cost Index shows average annual index values of 283, 267, 260, and 248 for the years 1957 through 1960. When translated to percentage terms, the decreasing index values imply successive annual reductions in construction costs of 5.7%, 2.6% and 4.6%; an overall reduction for the three year period of 12.3%. The general pattern of bidding during the final quarter of 1960, however, suggests that bridge construction costs have completed the cycle which began with the low point in the recession year 1954 and which then moved rapidly upward with annual increments of 4.1%, 16.2%, and 6.8% for the years 1955, 1956, and 1957 respectively. In all probability costs will again move upward in 1960.

The level of cost for successive periods is presented graphically in the accompanying chart which summarizes the course of California bridge construction costs since 1934.

Construction Activity

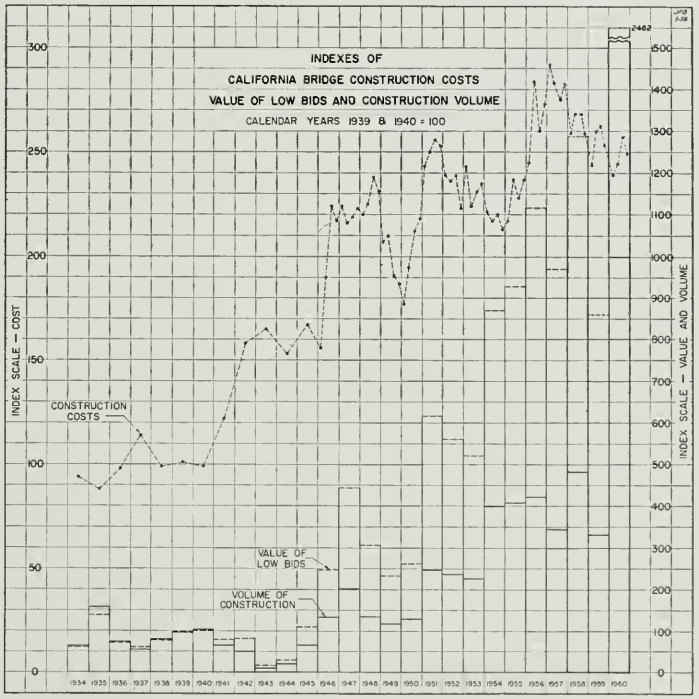
One hundred forty-three contracts with a total value of $127,862,803 for bridge work only were awarded during 1960. This value is about twice that of the previous record which had been established in 1958 when contracts with a total value of $65.1 million were awarded. The large increase in the number of awards for 1960 is largely attributable to the release of Interstate Funds for a number of large projects which had been deferred in 1959 due to the curtailment of those funds. The largest group of deferred projects were those for completing the portion of the Santa Monica Freeway in Los Angeles from 8th Street to Oak Street, with a total value for bridge work of $21.4 million.

Bidder Activity

The intense bidding activity which was so prevalent during 1959 extended into the first quarter of 1960 but then began to weaken as, presumably, the work loads carried by the contracting organizations increased to a profitable level. Consequently the average number of bidders per project dropped from the average of 8.8 per project during 1959 to 7.3 during 1960. Moreover it was noted that the heavier bidding during 1960 generally favored those projects with values less than $500,000, an indication that the smaller contractors were still looking for work. During the final quarter of 1960 the average number of bidders per project dropped off slightly to 6.9. Bidding during the first month of 1961 is down still further, to 4 and 5 bidders per project. The trend for 1961 therefore points to a year of relaxed competition and, consequently, to the probability of increased construction costs.

Average Unit Prices

Unit prices for various bridge items were relatively unchanged from those of 1959. The unit bids received for the items included in the large and highly desirable projects, such as those for the Santa Monica Freeway and the Yolo Causeway, exerted a strong depressing effect upon the average unit



costs of the major items of construction. Unit bids for items included in the more modest contracts were generally similar to those of the preceding year.

Class A portland cement concrete (bridge) cost an average of $50.62 during 1960, down $1.28 from the average of $52.00 per cubic yard during 1959. The relatively small reduction was, however, associated with a contracted quantity of 1,036,000 cubic yards of concrete so that the savings realized on this one item were in excess of $1,000,000.

Structural steel (plate girder). There has been little change in the cost of this item since 1958. The average prices for the three years, 1958, 1959 and 1960, are $0.164, $0.163, and $0.169 per pound. There seems to be a slight tendency for the price of this item to move upward.

Bar reinforcing steel. The most dramatic change over the past three years has occurred in the price of this item. The average unit costs during 1958 and 1959 were $0.124 and $0.113 per pound. During 1960 the price dropped to $0.097 per pound. The reduction in the unit cost of this item was especially significant during 1960; for during this year the Bridge Department contracted for 262,536,000 pounds of reinforcing bars. At the reduced price the savings for the item are in excess of $4,000,000.

New Technique

Prestressed concrete. This relatively new construction technique is applied in a variety of forms to bridge design. Some of the more common applications are in the form of "I" girders, "T" girders, inverted "T" girders, channels, and slabs. Rarer now but steadily increasing is the precast-prestressed box girder and the cast-in-place post-tensioned box girder. In terms of dollar value, the Bridge Department contracted for $4,406,000 of the prestressed type of construction during 1960, a value which represents 3.45% of the total outlay.

The summary unit cost of prestressed concrete has been developed in terms of the cost of a composite cubic yard of prestressed concrete in place. The cost therefore includes the cost of the concrete, reinforcing bars, stress steel, anchorages, prestressing operations, as well as erection costs.

The average cost per composite cubic yard of prestressed concrete for the years 1955 to 1960 inclusive has been $135.27, $163.03, $164.48, $144.74, $134.92, and $138.97 for the six successive years respectively. The net reduction in the cost of the item for the three year period since 1957 is 15.9%, a reduction which is 3.6% greater than the overall reduction in costs during the same period. This evidence points to the fact that the prestressing industry is continuing to increase its competitive position among the various materials used for construction.

Summary

As a result of the carry over into 1960 of the large number of projects which had been deferred during 1959, the bridge construction program attained a record valuation of $127,862,803. Comprising this valuation were 143 contracts which call for the construction of 531 structures, including such monumental structures as the Santa Monica Viaduct, the Yolo Causeway, the Caldecott Tunnel, and the Hazelview Tunnel.

Along with the record valuation there occurred another drop in construction costs, a drop which is calculated as 4.6% below the level of 1959. On the basis of the total contract valuation of $127.8 million, about $5.8 million in real savings accrued to the bridge construction program during 1960.

Toward the close of the year, however, it became increasingly evident that the construction organizations began to lose a part of the enthusiasm which characterized their bidding for projects during 1959 and the early part of 1960; the average number of bidders per project began to fall off and the prices for various items of work began to increase. It is very likely now that the bottom of the cycle has been reached and that prices will increase. However, since the bridge construction program is expected to stabilize at an annual value of $100,000,000, competition for future projects will probably be sufficiently aggressive to ward off the possibility of any major increases in construction costs.

Automatic Counters Save $300,000 Yearly

California's vehicle traffic counts, conducted by the Division of Highways, will go "automatic" this year at an estimated savings to taxpayers of close to $300,000 annually.

New electronic and mechanical equipment will be used to take the regular and special counts which for the past 37 years have been made almost entirely on a manual basis. The traffic count data help indicate which parts of the California State Highway System are adequate and which should be augmented or replaced.

The new machines will be paid for out of the first year's savings in wages previously expended for the two-day annual July statewide traffic counts. After the first year of mechanical traffic counting the cost of the operation will be reduced from $650,000 to an estimated $360,000 annually.

As many as 6,000 "once a year" employees have been hired in the past to count traffic on a Sunday and Monday in mid-July in order to help establish the average daily traffic on the state highway system.

These employees were required to count the number of vehicles and to indicate how many were automobiles, automobiles with trailers, buses, pick-ups, and freight vehicles by number of axles.

A close examination of these data accumulated over the past 37 years has enabled highway engineers to closely estimate the proportion of certain types of vehicles to be found in a total traffic figure for a particular area. With only a total count figure now necessary in most cases, relatively simple machines can do the counting which was formerly done by "once a year" employees.

1.5 miles of State Sign Route 1 will be converted from expressway to full freeway standards between Soquel Wharf Road and Soquel Avenue in and near Capitola, Santa Cruz County.

HIGHWAYS EMPLOYEE WINS ENGINEERING DOCTORATE

Albert Edward Simmons, Assistant District Engineer, District IV, has been awarded the degree of Doctor of Engineering, thus becoming the first man in the Division of Highways so honored by the University of California since the inception of this doctorate.



ALBERT E. SIMMONS

The honor was conferred at the culmination of several years of graduate study and research on Simmon's part at the Institute of Transportation and Traffic Engineering. His doctoral dissertation was "Visibility Under Highway Lighting Conditions." This research resulted in a mathematical analysis of visual assessment and the objective determination of relative visibility, permitting the establishment of visibility criteria for highway lighting.

Lighting Meter Developed

From this research Simmons has designed and developed a highway lighting visibility meter that provides an objective appraisal of visibility, referenced to a standardized objective contrast.

A native of Fresno, California, Simmons attended Fresno State College for two years before enrolling at UC, where he received his B.S. degree in engineering in 1931. He received a Master of Engineering degree from the University of California in 1952.

Simmons first worked for the Division of Highways during the summer while attending Fresno State College. From June 1928 until September 1929 he worked in Districts I and VI before enrolling at UC, where he spent the summer of 1930 on a District III project.

Returns to District

Upon graduating from UC, he returned to District III, working for a time as Construction Inspector. In 1932, Simmons moved to District IX, where he became Chief Draftsman before leaving in 1937 to accept a promotion as Assistant Highway Engineer in District IV.

He became District Traffic Engineer in 1948 and Assistant District Engineer, Design, in 1950. Since then he has been responsible for the design of many urban and metropolitan freeways in the San Francisco Bay area.

He is a registered civil and electrical engineer and is accredited in Who's Who in Engineering.

A member of ASCE, ITE and APWA, he has also been honored by membership in Sigma XI, XI Epsilon.

Simmons lives in Berkeley, with his wife Dorothy and daughter Jane Ann.

RECENT RETIREMENTS FROM DEPARTMENT ANNOUNCED

Headquarters Office

Frank C. Balfour, Chief Right of Way Agent, 30 years; Rex H. Fulton, Senior Highway Engineer, 30 years.

District I

Ignatius F. Cramer, Highway Chief Clerk I, 39 years; John H. Kennedy, Assistant Highway Engineer, 37 years; George M. Prindle, Highway Equipment Operator-Laborer, 8 years; Clarence H. Sackett, Highway Superintendent, 34 years.

District III

John R. Benson, Highway Leadingman, 34 years; Howard O. Brushwood, Laborer, 21 years; Lewis A. Hawks, Highway Foreman, 28 years.

District IV

Sebastian A. Urzi, Highway Leadingman, 29 years.

District V

Charles L. Bunce, Assistant Highway Engineer, 29 years; Ralph J. Harrington, Highway Foreman, 34 years; Hugh Lyons, Highway Leadingman, 29 years; Melville Thomas Rhodes, Highway Engineering Technician I, 14 years.

District VI

Frank B. England, Highway Engineering Associate, 31 years; Henry H. Rickels, Highway Leadingman, 26 years.

District VII

Carrie S. Neff, Senior Stenographer Clerk, 27 years; Oscar P. Puterbaugh, Highway Equipment Operator-Laborer, 23 years; Robert W. Vanstan, Senior Highway Engineer, 37 years.

District VIII

Loren S. Moore, Senior Highway Engineer, 22 years.

District XI

Joseph Malter, Laborer, 16 years.

Bridge Department

Charles L. Caldwell, Assistant Bridge Engineer, 26 years; Charles W. Jones, Supervising Bridge Engineer, 41 years.

Shop 7

Albion R. Albright, Highway Equipment Mechanic, 17 years; William H. Davies, Machinist, 27 years; Gene Skipworth, Blacksmith, 38 years.

Department Awards $6 Million Contract

The State Department of Public Works has awarded a $6,114,848.90 contract to B. J. Ukropina, T. P. Polich, Steve Kral & John R. Ukropina, San Gabriel, for grading and paving 2.9 miles of eight-lane freeway on the Ventura Freeway between the Hollywood Freeway and Buena Vista Street at Burbank in Los Angeles County.

Fourteen traffic separation bridges and one pedestrian crossing structure are included in the project.

This project, together with a 2.2 mile freeway project to the east, will complete the extension of the Ventura Freeway from the junction with the Hollywood Freeway to the Golden State Freeway.

UNDERSECRETARY NAMED

Clarence D. Martin, Jr., of Santa Monica, is the new Undersecretary of Commerce for Transportation. He was appointed by President Kennedy in January. Martin is a Harvard graduate, and the son of former Governor Martin of Washington. He operated an automobile agency in Santa Monica and was active in civic affairs.

FLOOD PROBLEMS

Continued from page 60 . . .

of Napa. The District and the County then proceeded to study the project in complete detail and eventually in July 1956, a co-operative agreement was executed by State and County.

Since completion, this drainage system has undergone at least one severe operational test. During the heavy storms of 1958, which caused widespread flooding throughout the State, the system operated satisfactorily and all flows were contained within the banks of the collector and outfall channels. The State Highway and properties served by the new system were well protected and experienced none of the flooding evident in previous years.

HEALDSBURG CO-OPERATIVE DRAINAGE PROJECT

By H. S. NG,
Highway Engineering Associate

Under Contract 60-4TC36F the construction of the 4.4 mile section of Healdsburg Bypass on U. S. 101 began on September 1959. This new alignment of the freeway is located west of the City of Healdsburg and traverses a valley which is the flood plain of Dry Creek. This valley is covered by prune orchards and scattered residences and generally drains toward Norton Slough and West Slough, as shown on the map.

Historically this low area has been subjected to flooding from two sources: occasional overflow from Dry Creek on the west and frequent local overflow from Norton Slough and West Slough.

In the design of the drainage system for this area, it was found that with the proposed freeway embankment, while it would alleviate the flooding problem in a portion of Healdsburg, would reduce the flooding area on the west, with a resultant higher flood stage during the flooding period on that side of the freeway. Two alternate plans were studied to determine means of alleviating this condition:

Plan No. 1

To construct 1.3 miles of channel change with 30′ bottom width section between the west frontage road and the freeway as diversion of Norton Slough and to intercept overflow from Dry Creek.

Plan No. 2

To place sufficient cross-drain structures under the freeway embankment as equalizers.

Officials from Sonoma County, the City of Healdsburg and interested private property owners were invited to discuss these proposals. As the result of many discussions between the State and local agencies, Plan No. 1 was adopted.

In a co-operative agreement with the Sonoma County Flood Control and Water Conservation District, the State obtained the necessary right of way and constructed the channel change with the County being responsible for the future maintenance of the channel.

To insure efficient operation of the new channel change, improvement of 0.9 mile of the West Slough outfall channel between the freeway and Magnolia Drive was also included in the co-operative agreement. For this portion the County obtained the necessary right of way with the State doing the construction work.

Approximately 168,000 cubic yards of excavated material from both the channel change and the outfall channel improvement were used as roadway embankment and expensive cross drainage structures were eliminated. Construction cost of this drainage system was estimated to be no greater than the other alternate drainage plan under consideration and effected some savings in roadway embankment.

Shortly after the channel work was completed, Dry Creek overflowed (February 6, 1960) after a few days of heavy rainfall. As anticipated, the new channel performed satisfactorily and only minor local flooding occurred. From observation of its performance and confirmation of expected construction savings, it is evident that this channel change is well justified.

This is the first of a two-part article on drainage and flood problems in the District IV area. The second part will appear in the next issue of the magazine.

State Fatality Toll Nears All-time High

California's 1960 traffic fatality toll rose to within 81 of the all-time mark, final figures by the California Highway Patrol have revealed.

Patrol Commissioner Bradford M. Crittenden said the official tally was 3723. The highest year on record was 1956, when 3804 died in motor vehicle accidents.

"The figure is dismal even when it is known that the rate of fatalities per 100 million miles of vehicular travel held steady at 5.3, the same as 1959," the commissioner said.

"The 3723 figure means that slightly over 10 persons per day met violent death on our state's highways and streets. Many of these deaths were the result of mistakes or carelessness, momentary lapses which were the signal for tragedy to step in. Others resulted from willful violations of the traffic laws in which the guilty driver deliberately ignored the potential consequences of his action.

"No matter what your job or profession, remember that when you are behind the wheel, driving is your occupation. It requires total attention. There can be no distractions. Driving is too serious to be considered a game or avocation. It is a business. Make it a good business by applying the techniques of safe driving," he concluded.



The above photo, sent by Charles Herrick of Norway House, Manitoba, Canada, shows a type of vehicle used in his area over frozen lakes and rivers in winter. "We have no highways here," writes Herrick, "and must use boats during navigation season. Thought the photo might be of some interest to your readers." The insignia on the snowmobile door is that of the Manitoba Provincial Game Branch.

'TEMPUS FUGIT' CORNER

The following items appeared in the March-April, 1936, issue of *California Highways and Public Works.*

A SEVERE WINTER

Not since the state inaugurated snow removal operations on the Donner summit route over the Sierra Nevada (1931) has the Division of Highways been called upon to combat such storm conditions as it encountered in that area last month.

A total of 161 inches of snow fell on the Donner Summit route during 24 days in February. The highway was closed to all traffic for only 34 hours during the entire month due to poor visibility, drifting or snow slides on four separate occasions.

CHICKEN FEED

The State has only $15,469,891 from gas tax and motor vehicle fees for major highway construction during the current biennial period.

KISMET

For several years, officials have been perplexed at the attitude of calm acceptance with which the motorists have taken accidents. * * * There is considerable volume of evidence to show that only a small percentage of accidents are due either to physical condition of the roads or to the mechanical condition of the vehicles. * * * Traffic accident study reveals major highway casualty factors are bad driving, high night speeds, and pace differential between trucks and autos.

Commission Votes L.A. Freeway Funds

The California Highway Commission has allocated $1,250,000 for freeway structures and approaches on sections of the future San Diego Freeway route between Clark Avenue and Lakewood Boulevard in Long Beach. The project will include construction of the Willow Street Undercrossing and pumping plant, and the Clark Avenue Undercrossing, as well as the relocation and improvement of the Bouton Creek channel.

IN MEMORIAM

District II

Hugh D. Fields, Highway Equipment Operator-Laborer.

District III

Willard V. Small, Highway Leadingman.

District IV

Oliver J. Welsh, Senior Account Clerk.

District VII

Victor Nandino, Assistant Highway Foreman.

Harry R. Welch, Associate Right of Way Agent.

District IX

Charles T. Kispert, Highway Foreman.

District X

Ruben Laxson, Janitor Foreman I.

State-Owned Toll Bridges

Seldon F. Del Giorgio, Toll Captain.

Ellis L. Armstrong Becomes BHIF Chief

Ellis L. Armstrong, U.S. Commissioner of Public Roads since October, 1958, left his Federal post to become president of the Better Highways Information Foundation on January 24.

The B.H.I.F. was organized in 1960 under sponsorship of the highway construction industry. Its objective is "to develop public understanding of the need for and the benefits from long-range soundly financed programs for highway system development in the United States."

Armstrong visited California in March, including speaking engagements in Los Angeles, Stockton, Berkeley and Sacramento.

Of 1977 fatal accidents investigated by the California Highway Patrol in 1960, 1111 were in the one-car category. The implication is obvious. In the majority of last year's fatal accidents, the driver of the involved car had only himself to blame.

Federal Aid Head Rod Reynolds Leaves

Rodney F. Reynolds, assistant office engineer for the California Division of Highways, has retired after 42 years of continuous service with the state highway agency.

Since 1930, Reynolds has headed the highway division's Federal Aid Section, which is concerned with the necessary federal approval of plans, and cooperative state-federal financing for projects on California highways included in the various federal road systems.



R. F. REYNOLDS

When Reynolds was placed in charge of this section 31 years ago, the annual federal expenditure for highway work in California was approximately $4,180,000.

This yearly total has increased steadily since then, as a result of accelerated highway programs nationally, combined with California's spectacular population and motor vehicle gains. In the current fiscal year, a total of $218,484,000 in federal funds will be spent for highway improvements in this state.

Reynold's career with the Division of Highways began in 1919, when he was engaged in location surveys in Northern California, including work along the lower Trinity River and in the Feather River Canyon.

From 1923 to 1930 he was assigned to maintenance and construction operations on highways in the northern part of the state.

Reynolds was born in San Francisco April 19, 1899. He attended schools in Alameda. He is a member of the Knights of Columbus, U. S. Coast Guard Auxiliary, and the National Audubon Society, and a charter member of the California Employees Association.

He and his wife, Verna, live at 5311 Pleasant Drive, Sacramento. They have one daughter, Mrs. James Mercer Glynn of Chicago, and two grandchildren.

Circular Letters

New Management Section Streamlines Procedures

By ALFRED S. ROXBURGH, Senior Administrative Analyst, and
GEORGE F. ANDERSON, Associate Administrative Analyst

PICTURE to yourself approximately 20,000 letters on your desk making a stack 10 feet high, all of which you must read.

This was the task before the staff of the Management Analysis Section in cooperation with each originating office at headquarters when the State Highway Engineer in April 1958, authorized a program for coordinating and improving the Division's circular letter system.

The circular letter system has always been a vital means of communication and management in the Division of Highways. The circulars transmit announcements, instructions, procedures, and policies from management to all district engineers and department heads.

The need for communication and management was a task which faced California's first Highway Commission and the first State Highway Engineer, A. B. Fletcher, as they began the task of developing a unified system of state highways in California in 1911.

The text of the oldest circular letter contained in the file, dated February 20, 1912, from State Highway Engineer A. B. Fletcher to "The Several Division Engineers of the California Highway Commission" is given below.

CALIFORNIA HIGHWAY COMMISSION

Gentlemen:

In several of the expense accounts the transportation charges on goods were included in the various schedules of the furniture, equipment, etc., which materials were to have been delivered at the office without further expense to the Commission. The amounts of these charges will, of course, have to be deducted from the bills of the firms supplying the materials. Please send me a statement at once of all transportation charges which you have paid on materials included in any of these schedules, or of typewriters or any other materials which were supposed to have been delivered without further cost.

As far as possible, avoid paying these charges in the future. Where the payment is necessary in order to obtain the goods, notify this office at once lest the bill for the goods be paid before your expense account arrives.

As the years passed and the state highway organization grew to meet the needs of the state so grew the communication problem. The task assigned to the Division's Management Analysis Section was to streamline this primary system of communication in order that the Division could more effectively carry out its task of building and maintaining a road system to meet California's tremendous road problems.

The authorization for a full study of the circular letter system was a result of a preliminary study initiated in 1956, by the Advisory Committee on Management Controls. That study was to review the possibility of improving the circular letter system for the Division of Highways.

The analysis of circular letters included a detail screening early in 1957 of all circulars issued during 1954, 1955, and 1956 to identify and list about 370 active circulars out of over 900 circulars issued during these years. The cooperation of all departments, and particularly of the Office Engineer, who made available his circular letter file, made this phase of the study possible. Part of the task of analyzing the accumulation of circular letters was completed and a procedure for screening was tested.

While the cooperation of all departments was essential, Management Analysis served as the focal point for carrying out the succeeding recommendations of the report.

The staff continued the process of screening circulars, applying it to earlier periods and publishing lists until all circulars now in effect have been identified and listed. After the first screening the General Files collection of circulars was used as a basis for this screening, rather than the Office Engineer's collection, because the former was filed chronologically which proved to be more convenient for the screening.

Lists already prepared for 1954, 1955, and 1956 Division circulars which were still in effect, were updated.

Indexes of active circular letters covering the years 1953-1958 were published in January 1959 and in April 1959 an index covering all active circulars during 1947-1952 was published. These lists were distributed to all departments and districts.

Standards and controls were established to facilitate the system. These include:

Use of a distinctive heading which clearly identifies circulars. Included in the heading is an expiration date in order to permit automatic removal from active files. The specific expiration date is either a date five years from the issue date, or when appropriate, an earlier date. It is planned that if after five years, circular letter material has not been included in a manual and is still in effect, it should be reissued as a new Division circular.

Assigning of consecutive numbers for each calendar year as an over-all control and an aid in chronological filing.

General subject classifications were assigned, using the name of the originating unit in headquarters, as an aid in subject filing and reference, for example, Construction, Office Engineer, Right of Way, etc.

Separate consecutive numbers for each general subject classification are assigned as a further control and an aid in subject filing and reference.

Reference to all previous directives which are affected by a new circular are contained in the new circular.

The system also stresses avoiding "patchwork" modification of previous circulars, where successive directives change parts of earlier directives

which in turn amend still earlier directives. In general, a new circular is issued and the earlier ones replaced entirely after one or two amendments or if the amendments makes fairly extensive or complex changes.

When new or revised manuals are published, departments originating the manual are responsible for determining the effect on circular letters and specifically rescinding all Division circular letters incorporated in or replaced by the manual.

The system also distinguishes between division-wide circular letters and the directives addressed only to headquarters staff. A separate system of Headquarters Office Instructions was established.

Under the general responsibility assigned the Assistant State Highway Engineer, Administration, the Management Analysis staff has now completed the installation and launching of the circular letter system with the issuance of a master circular letter index for all active circular letters up through 1959. Each year this index will be updated and reissued.

With the assistance of those concerned the staff believes the system has improved the accessibility of the Division policy and procedure information throughout the organization, as well as to make it easier and faster to locate the standing instructions by which operations are to be guided. The future review and revision of instructions to meet changing conditions will also be facilitated.

C.H.C. Considers Westside Routing

The California Highway Commission has taken under consideration the adoption of a freeway routing for 32.2 miles of the Westside Freeway (State Highway Route 238) in San Joaquin and Sacramento Counties between Benjamin Holt Drive at the north city limit of Stockton and 0.8 mile south of Freeport.

The Westside Freeway will extend along the west side of the San Joaquin Valley northward from Wheeler Ridge in Kern County and through Sacramento and Yolo Counties to Woodland. The route has been adopted from Wheeler Ridge through Stockton and in Yolo County from the Sacramento River to Woodland.

Plans of the Division of Highways call for the construction of a six-lane freeway at a cost of approximately $28,700,000, including rights of way. Start of construction would depend on the availability of future highway funds. The route is on the National System of Interstate and Defense Highways.

DRIVER REACTION TESTED BY SIMULATOR DEVICE



This is a view of one of the driving simulators demonstrated to engineers and scientists attending the Notional Conference on Driving Simulation held February 27 to March 1 in Santo Monica. Driver reaction to highway features is tested by projecting a motion picture of the roadway onto a curved screen in front of the vehicle. A synchronized rear view of the road visible in a rear view mirror adds to the effect of realism. Pretesting of driver behavior by such a device could be of considerable aid to highway designers and planners in predicting reaction to various types of signs, lighting and other roadway conditions.

25-YEAR AWARDS GIVEN 18 EMPLOYEES

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Herman W. Deltorchio

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District III
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Bosilka Russell

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District X
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State-Owned Toll Bridges
Glenn F. Davis

Materials and Research
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EDMUND G. BROWN, *Governor*

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J. W. TRASK . . . Deputy State Highway Engineer
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HOWARD C. WOOD Bridge Engineer State-owned Toll Bridges

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LEONARD CHERNOFF . Supervising Electrical Engineer
ROBERT J. PALEN Supervising Estimator
R. J. CHEESMAN . . . Chief Architectural Draftsman
H. C. JACKSON . . Supervising Specification Writer

CONSTRUCTION SERVICE—CHARLES M. HERD . Chief Construction Engineer

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THEN

In 1930 Sepulveda Baulevard in Sawtelle was a quiet, tree-lined street. Every minute ar so a car wauld drive by. Sametimes there was a little cangestion at the intersection with Wilshire ar Santa Manica Boulevard, but Sepulveda in its rale as a north-sauth connection between the towns af the western Las Angeles area was nat called upon ta handle much af a traffic load.

The phata below, taken 30 years later than the ane abave, shows approximately the same sectian af street, laoking sauth taward the Santa Manica Baulevard intersectian. The pepper trees have been trimmed, curbs installed, and the street striped far faur lanes. Despite these improvements, Sepulveda (then State Sign Raute 7) became campletely inadequate to handle the constantly increasing traffic load. State Sign Route 7 taday may be seen in the right side af the phata belaw. It has become the eight-lane San Diego Freeway (Interstate 405), carrying 65,000 cars daily.

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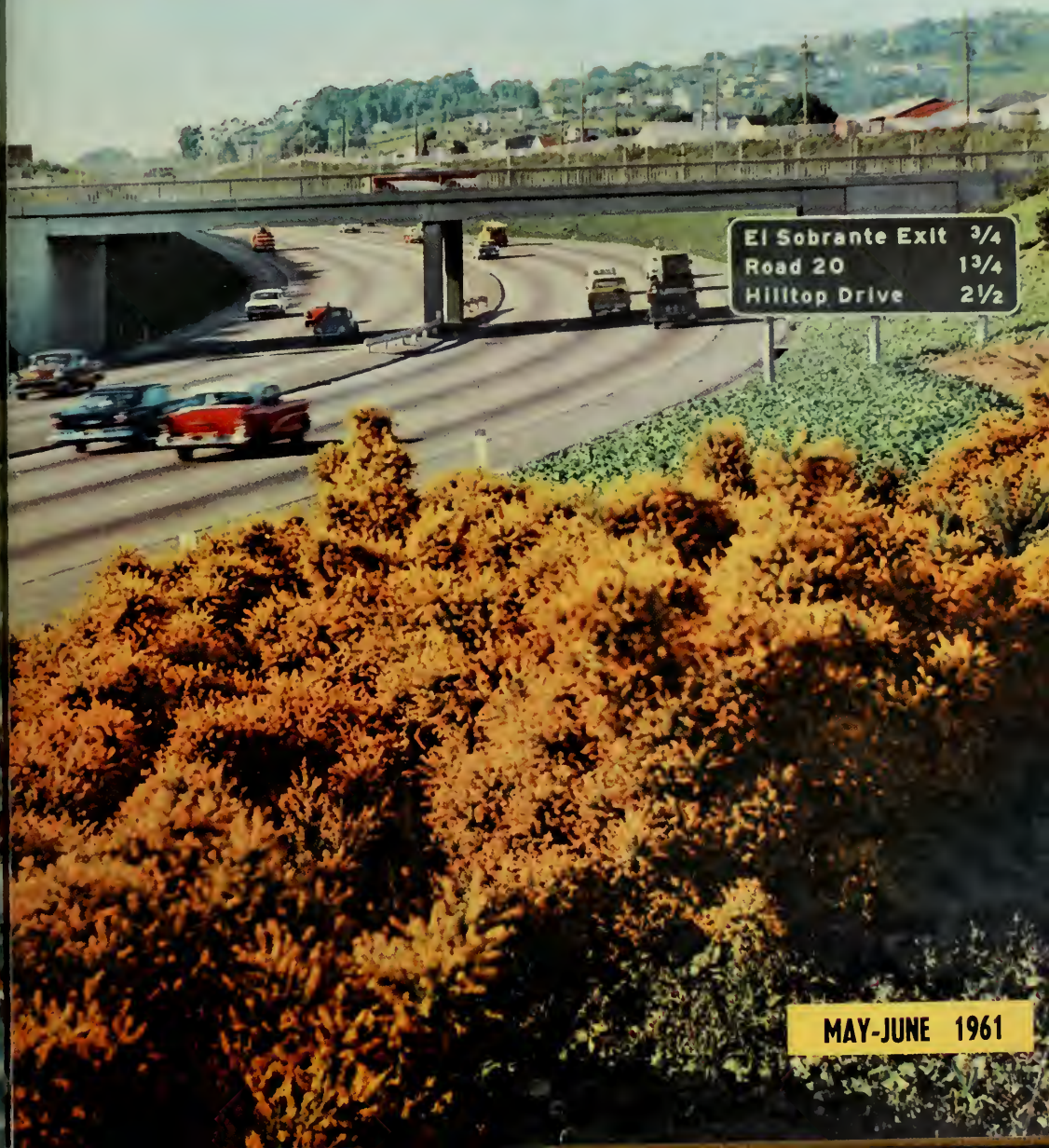
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CALIFORNIA Highways and Public Works



MAY-JUNE 1961

National Highway Week Observed

THE WEEK of May 21-27, 1961, was observed throughout the United States as National Highway Week.

The observance was made official by virtue of a proclamation issued by President John F. Kennedy, in which he called attention to the importance of completing the National Interstate System of Interstate and Defense Highways on schedule in 1972 and pointed out that "The orderly advancement of our expanded Federal-State highway program promises a sharp reduction in our annual waste of human and economic resources due to outmoded highways."

In California, Governor Edmund G. Brown also cited the contribution of better highways to the public safety and economic growth *(see statement)*.

The observance was given added significance in California by virtue of this year's being the 50th anniversary year of this State's modern-day highway program. The California Highway Commission was created in 1911.

Newspapers throughout the state carried accounts of recent and current construction progress in modern highway construction, with emphasis on Interstate System and other freeways.

State Highway Engineer J. C. Womack was quoted as noting that California has increased its total of multi-lane divided highways by nearly 1,000 miles in the past six years. The State now has approximately 2,300 miles of multi-lane divided highways in operation now. Most of the recent construction has been of the full freeway or expressway type.

Womack also pointed to the progress in highway planning, as evidenced by the pace of freeway route adoption actions by the California Highway Commission. The Commission has now adopted routes for 5,560 miles of controlled access freeways and expressways, an increase of 2,670 miles in six years.



STATEMENT

The demands of a growing and mobile economy, the interests of national defense and the urgent need to relieve the suffering caused by accidents are constant pressures for better highways to serve our nation.

In California, we are meeting these challenges by building thousands of miles of freeways and expressways and by improving roads that are no longer adequate to the burdens placed upon them.

President John F. Kennedy has proclaimed the week of May 21-27 as National Highway Week in recognition of the vital role our highways play in the continued growth and prosperity of America.

As Governor, I urge all Californians to share in the observance of this week. I urge also that we take this opportunity to pay tribute to the thousands of engineers, contractors and construction workers who work so hard to keep America on the move.

Edmund G. Brown

EDMUND G. BROWN, Governor

In some parts of the state, notably Southern California, interested organizations sponsored special events. Undersecretary of Commerce Clarence D. Martin, Jr. spoke at a luncheon in Los Angeles, and a dedication ceremony was held for a completed portion of the East Los Angeles Interchange now under construction. A special television program featured the proceedings at a public meeting in Escondido regarding freeway route location studies in that area.

A number of newspapers ran special articles on highway developments in their respective areas of the state. The Oakland *Tribune* featured a series of National Highway Week articles by its highway specialist, Dave Hope.

Part of the observance of National Highway Week was a dedication ceremony signalizing the opening to traffic on a portion of the East Los Angeles Interchange on May 23. Highway Commissioner Roger S. Woolley is shown speaking. Behind him is former Highway Commissioner Harrison R. Baker, president of the Los Angeles Metropolitan Traffic Association. At far left, with notes in hand, is Highway Commissioner Robert E. McClure, accompanied by District Engineer A. L. Himelhoch of District VII.

The trucks in the background are using the newly-opened ramp connection from the Golden State Freeway to the Santa Ana Freeway. The structure on which the participants are standing is a connection between the Santa Monica and Golden State Freeways; the structure is completed, but will not be in service until a portion of the Santa Monica Freeway across the Los Angeles River is open to traffic later this year.

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FRONT COVER—Looking north on U.S. 40 through Richmond at the Solano Avenue Overcrossing. Scotch broom, ground cover and other shrubbery plantings were completed in 1959 along the slopes of this section of depressed freeway. Photo by John F. Meyerpeter

BACK COVER—Many of the steel bridges on California's highways are being painted green to blend with natural colors of adjacent terrain and foliage. One of the first to receive this treatment is the Noyo River Bridge on Sign Route 1 in Mendocino County, shown here. Photo by John F. Meyerpeter



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Route Adoptions

Commission Approves Freeway Locations

IMPORTANT freeway routes in both northern and southern California were adopted by the California Highway Commission in February and March.

These included a route through Glendale and the Eagle Rock section of Los Angeles County; a route in Los Angeles, San Bernardino and Riverside Counties skirting the cities of Pomona, Chino and Ontario; a route in Santa Clara County involving the cities of Gilroy, Morgan Hill and San Jose, and a beltline route around and to the north of Sacramento.

The Glendale-Eagle Rock adoption involves 6.6 miles of freeway on Sign Route 134 and the action was taken following a public hearing by the Commission in Los Angeles. The Commission followed the recommendation of State Highway Engineer Womack for a route through Glendale, but adopted a route referred to as the "D" line through Eagle Rock, a route located a quarter to a half mile north of the route which Womack had recommended.

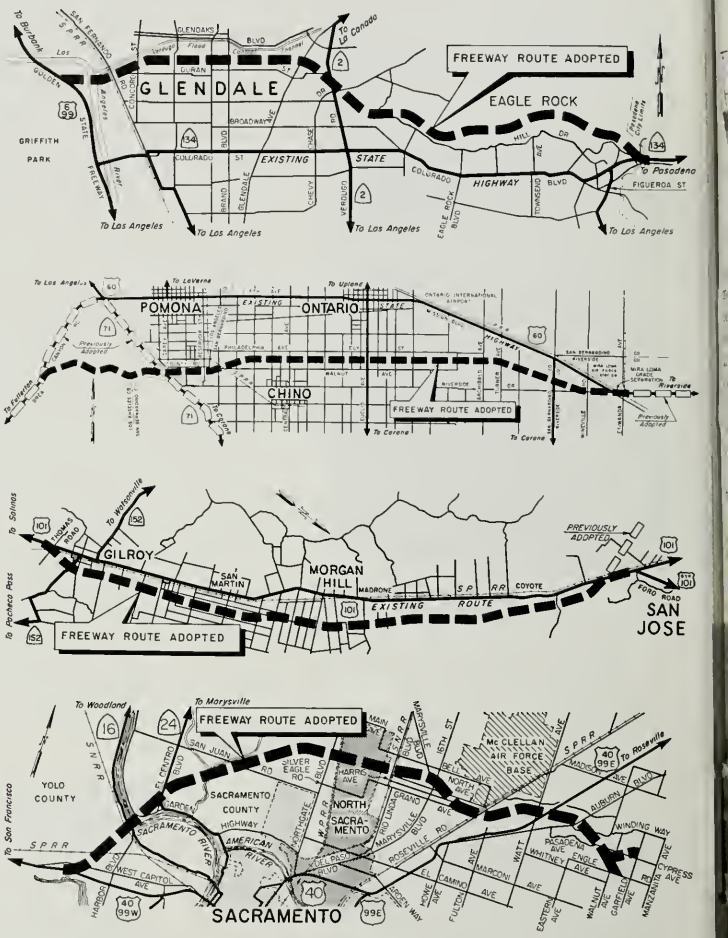
For the 13.9 miles of freeway in the area of Pomona, Chino and Ontario the Commission adopted the route recommended by Womack from Sign Route 71 at Garey Avenue to Mira Loma Grade Separation. The Commission urged Womack, in designing the freeway, to depress it under city streets and county roads in the Chino area. If this should involve serious engineering and financial problems, Womack is to refer the matter back to the Commission for further comment, but not in regard to location.

The adopted Santa Clara County route is for 24.6 miles of freeway for U.S. 101 between south of Gilroy and San Jose. The Commission's decision was based on freeway route studies dating back several years, a public hearing in San Jose in January, 1961, and the recommendation of Womack.

The Sacramento beltline route, adopted in March, will form a component part of a proposed freeway network in the metropolitan area of the Capital. It is designated as Interstate Route 880 and connects with U.S. 40 (Interstate 80) in Yolo County and north-east of Sacramento near Watt Avenue.

There were two other freeway route adoptions in March. One was for one of the last links in the complete routing of the Westside Freeway. The newly adopted route extends 32.2 miles from Benjamin Holt Drive at the north city limit of Stockton to 0.8 mile south of Freeport in Sacramento County.

The other adoption was a route for the relocation of 7.6 miles of U.S. 399 in Kern County between 2.25 miles northeast of Valley West Road and 0.2 mile east of State Highway Route 139 (Enos Lane).



Bay Area Freeways

By J. P. SINCLAIR, Assistant State Highway Engineer



"Routes, Roads and Rolling Wheels" is not the title of an "adult western," but a new 3-R twist to a chapter heading on highway transportation in the social studies text of California's fourth graders. In other elementary classrooms, students are discussing articles in the April 5, 1961, issue of "Junior Scholastic" magazine about the impact of change on our communities; the problems of population, housing, transportation, greenbelts, urban renewal and suburban development.

President Kennedy has stressed the need for all citizens, all levels of government and for all business and industry to plan for future growth on a coordinated basis. Recently, at M.I.T., scientists from 30 nations met to discuss similar problems on a global basis prompted by the effects of technology and population explosions in a shrinking world community.

These considerations are not removed from the subject at hand—the vital role of freeways today. Since freeways are planned to meet condi-

Portola School
April 3, 1961
Los Altos, Calif.

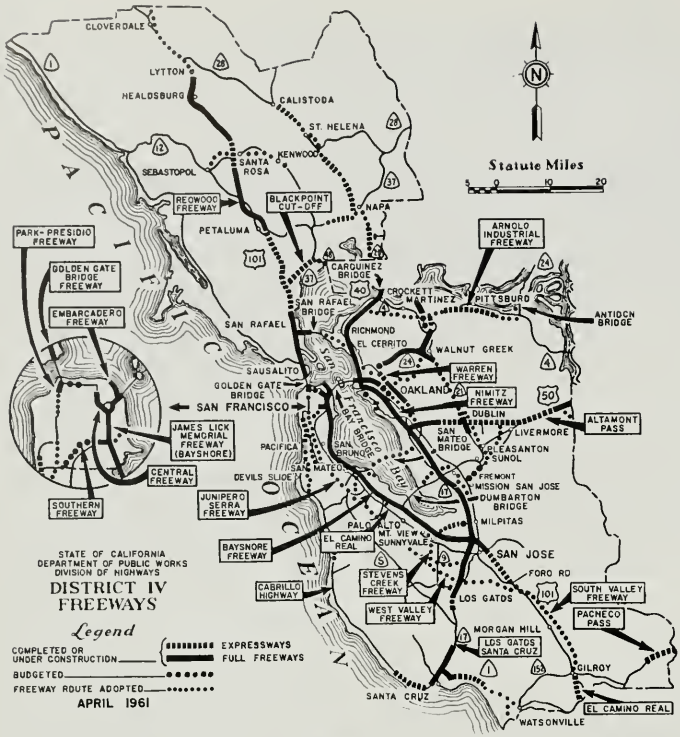
Dear Sirs:
I am making a report about Routes, Roads and Rolling Wheels. I would like to have pictures of road signs.

Thank you.
Curt Heskett

A letter typical of the many received from young school children requesting information on some phase of the highway program for projects they are doing in class, this one from Curt Heskett of Los Altos.



Looking north at construction operations at Greenbrae on U.S. 101. The new off-ramp bridge connection to San Quentin and the Richmond-San Rafael Bridge is located right foreground. The old bridge is being removed at the center.



A map showing the current status of freeways in the Bay Area.

tions 20 years hence, the best estimate of the future is basic to freeway planning. The young and the not-so-young must think in terms of the future; the young, because they will inherit our freeways and, hopefully, benefit from our experience; the not-so-young, because action is imperative. To procrastinate means chaos.

Freeway Impact

District IV is charged with planning, designing, constructing and maintaining San Francisco Bay Area freeways. The rapid development of our freeway system has raised immediate questions regarding community values and has focused attention on the considerable impact of freeways. This has dramatized the gap between freeway planning and other aspects of community planning. In turn, the various cities, counties and civic groups have responded by dusting off old, and implementing new comprehensive long-range plans to channel explosive growth into orderly patterns.

The policies and procedures established by the California Highway Commission for route selection and freeway design are directed at obtaining a maximum of community involvement. Studies are announced, alternative routes are presented, and detailed plans are reviewed through a continuing series of local public meetings and discussions with community planners.

It is during this three to five-year process that the freeway is integrated with all aspects of present and predicted area development. Route recommendations and design features are considered in light of the intangible and aesthetic, as well as the functional and economic factors which are brought out. The continuing re-examination of changing conditions as a basis for planning is essential. These plans become tomorrow's realities which in turn influence subsequent growth patterns.

The following review of construction progress and planning activities detail one facet of Bay Area growth.

U.S. 40—San Francisco to Carquinez Bridge

This important link of Interstate 80 was completed in August, 1960, when the portion of the Eastshore Freeway between El Cerrito Overhead and Jefferson Avenue in Richmond was opened to traffic. Completion of 12 major projects, including the new Carquinez Bridge and Crockett interchange, now provide a minimum six-lane, high speed bypass to replace the undivided highway formerly traversed by eastshore commuters between Oakland and Vallejo.

The last link between El Cerrito Overhead and Jefferson Avenue included construction of a direct connection to Hoffman Boulevard, State Sign Route 17, in Richmond and diamond interchanges at Central Avenue and Carlson Boulevard. A detailed account of this $5,313,000 project appeared in the July-August 1960 issue of this magazine.

During 1960, functional planting was added between Ridge Road in San Pablo and Crockett, and sign panels were installed between Richmond and Crockett. A blocked-out metal beam median barrier was installed between the Distribution Structure and El Cerrito Overhead.

A $39,000 contract was recently awarded for landscaping the Crockett interchange and Carquinez Bridges, and $280,000 has been budgeted for landscaping the freeway between El Cerrito Overhead and Jefferson Avenue.

The major U.S. 40 project presently under construction is the Bay Bridge reconstruction, being financed by toll bridge funds. This work includes rebuilding of the approach ramps and the Bay Bridge itself to carry five lanes of westbound traffic on the upper deck with eastbound traffic on the lower deck. This work is being administered by the Division of San Francisco Bay Toll Crossings. Also under construction is the widening on the south side of the Toll Plaza. This contract, also financed by toll bridge funds, will provide 17 lanes through

the Toll Plaza eastbound. As a part of this $515,000 project, the eastbound toll booths are being remodeled so that all collections will be made from the driver's side.

U.S. 50—MacArthur Freeway

Work is in progress on four of nine MacArthur Freeway projects and a fifth contract is expected to be advertised this summer. This section of U.S. 50 between the Distribution Structure in Oakland and Castro Valley is being constructed as an eight-lane interstate facility.

The first section that can be used by traffic consists of three projects, expected to be completed in February of 1962, between the Distribution Structure and Grand Avenue. Construction on the first unit between the Distribution Structure and Market Street was started in February of 1960. This project, estimated to cost $3,113,000, includes one interchange and two undercrossings. The Adeline Street Undercrossing is nearly 1,100 feet long and spans four streets. The work is being done by C. K. Moseman and Son.

The second unit let to contract is from Broadway to Grand Avenue. Guy F. Atkinson is the contractor on this $4,383,000 project, which includes a modified diamond interchange with additional connections in the vicinity of Oakland Avenue and Harrison Street. Structures are provided for the Broadway-Richmond Boulevard, Oakland Avenue and Chetwood Street Undercrossings. Embankment is being placed on the adjoining unit of construction between San Pablo Avenue and Webster Street.

The third unit will close the gap between the projects mentioned above. Peter Kiewit Sons Company started this $4,045,000 project in August, 1960. The future directional interchange between MacArthur and Grove-Shafter freeways is included. At this time, only the substructures of the interchange spans will be constructed since the Bay Area Rapid Transit District has indicated a desire to occupy the median of the Grove-Shafter freeway and the matter is currently under discussion. However, nine additional structures are being



The MacArthur Freeway under construction, looking east from above the San Pablo Avenue Underpass.



U.S. 101 in Marin County looking south toward San Rafael.

provided for separation of city streets and ramps.

The fourth contract will extend the freeway from Grand Avenue to Park Boulevard in Oakland, a distance of 1.7 miles. Two interchanges, a modified split diamond in the vicinity of Grand Avenue and Lakeshore, and a half diamond at Park Boulevard, are included in this $5,000,000 contract. Peter Kiewit Sons Company was awarded this contract in March, 1961. Separation structures are provided at Lakeshore Park, Lake Park, MacArthur Boulevard and Park Boulevard. Pedestrian overcrossings are being built at Van Buren and Santa Clara and a stairway is provided in the vicinity of Lagunitas Avenue. Eleven major retaining walls are included in the contract to reduce right of way requirements.

The fifth unit is three miles in length between Park Boulevard and Buell Street in the vicinity of Mills College. The project will include six half diamond interchanges, 15 traffic structures and a pedestrian overcrossing. Again, in order to reduce right of way requirements, 19 major retaining walls are being constructed on this $8,700,000 project.

Eight million dollars for a 3.5-mile portion between Kuhnle Avenue and the east city limits of Oakland near Durant Avenue has been included in the budget for 1961-62 and is expected to be advertised in December. The 0.8-mile gap between Buell and Kuhnle Streets and the two units from Durant Avenue to 173rd Avenue in Castro Valley, a distance of 5.2 miles, are in an advanced design stage and rights of way are being acquired and cleared.

Approximately $50,000,000 has been expended or budgeted to date for this 15.3-mile freeway. The March-April 1960 issue of this magazine contained a detailed background article.

U.S. 50—Castro Valley to San Joaquin County Line

A continuous freeway has been in traffic service between Oakland and Dublin since 1957 via portions of the Nimitz Freeway (State Sign Route 17), Route 228 easterly to Castro Valley, and U.S. 50. East of Dublin, the traveled way is presently constructed to expressway standards with controlled access but with intersections at grade.

Construction activities within this area have been relatively slight, limited to minor grading and resurfacing, and a landscaping project between Center Street in Castro Valley and the Nimitz Freeway. The latter project was completed in February of 1960 at a cost of $83,400.

Design studies are in progress for freeway widening to eight lanes for a 6.8 mile portion between Crow Canyon Road and west of Dublin. Studies are more advanced for the development of the existing expressway to initial six-lane, ultimate eight-lane freeway between Dublin and Greenville.

U.S. 101—Golden Gate Bridge to San Rafael

Construction is expected to be completed in August, 1961, on the third and final stage of the Greenbrae Interchange. This $1,152,000 project being constructed by Peter Kiewit Sons Company, will create a three level separation structure which will provide a bridge ramp connection to Sir Francis Drake Boulevard for northbound freeway traffic. Also included in the contract is the removal of the old lift span bridge across Corte Madera Creek.

Completion of this project will provide a six-lane freeway north from the Golden Gate to San Rafael. However, planning studies are in progress to provide additional lanes on uphill grades between the Golden Gate Bridge and Richardson's Bay. Hearings have been completed concerning future expansion to eight-lanes between San Quentin Wye and Puerto Suello Hill in San Rafael. Design studies are underway.

A $61,700 landscaping project, including the planting of numerous redwood trees between Corte Madera Creek and Richardson Bay Bridge was completed in December, 1960. Similar landscaping is expected to commence in the near future between Waldo Undercrossing and Freitas Parkway if the necessary billboard ordinances are enacted by cities of Larkspur and San Rafael.

Several other projects have been budgeted and should be under construction in the near future. Two hundred thousand dollars is set aside for grading, paving and landscaping the Vista Point north of the Golden Gate Bridge. One hundred seventy-five thousand dollars is budgeted for widening the Marin approach to the bridge and the work is being coordinated to meet the Golden Gate Bridge and Highway District's plans for widening the northerly approach spans of the bridge.

U.S. 101—San Rafael to Petaluma

The first of many projects to convert this section of U.S. 101 from an expressway to a six-lane freeway was completed in January, 1961, between Lucas Valley Road and San Pedro Road. The work was done by Fredrickson and Watson Construction Company. Included in this $1,076,000 project was the trumpet-type Terra Linda Interchange at Manuel Freitas Parkway, frontage roads and a partial interchange at San Pedro Road in the vicinity of the new Marin County Civic Center.

Construction is expected to be completed in September, 1961, on the contract being performed by Charles L. Harney, Inc. at Miller Creek Road. The diagonal ramps and the freeway overcrossing of a future four-quadrant cloverleaf interchange serving the Marinwood development and St. Vincent's School are being built at this time. A northbound climbing lane over St. Vincent's Hill, is also included in the work, estimated to cost $633,000. The same contractor is reconstructing and extending a culvert at Gallinas Creek at the north city limits of San Rafael. This $125,000 project will improve drainage conditions and will minimize traffic problems during the construction of the future eight-lane freeway in this area.

Contracts for an initial six-lane, future eight-lane freeway from Miller Creek to north of Entrada Drive at Rafael Village just north of Ignacio and for an interchange at Ignacio Wye are expected to be ready for advertising early in 1962.

Studies are under way for an eight-lane freeway between Lincoln Avenue in San Rafael and Miller Creek for conversion of the existing expressway between Atherton Avenue in Novato and 0.3 mile south of Petaluma to freeway standards. Traffic origin and

destination surveys are now being evaluated for the unit between the Ignacio Wye interchange and Atherton Avenue in Novato.

About 1,000 trees, mostly redwoods, are being planted as part of a $62,000 landscaping project on the completed freeway in the vicinity of Washington Avenue in Petaluma.

U.S. 101—Petaluma to Mendocino County Line

By 1957, an 18.5 mile section of freeway was completed from south of Petaluma to the southerly city limits of Santa Rosa. Within the City of Santa Rosa the existing expressway has been in use for many years. Studies for the conversion of this facility to an initial four-lane, future six-lane full freeway are well along and rights of way are now being appraised and acquired.

Appraised 16 miles of freeway from the north city limits of Santa Rosa to Lytton will be in use with the completion of two contracts next year. Guy F. Atkinson Company is the contractor on a $4,386,000 project between Mendocino Avenue in Santa Rosa and Grant Creek. Five interchanges will be constructed between Santa Rosa and Windsor, and grading will be done between Windsor and Grant Creek. The second contract includes paving the graded portion between Windsor and Grant Creek and the construction of frontage roads and interchanges at Windsor and Grant Street. Ball and Simpson is the contractor on this $3,110,000 project.

North of the present construction, the Healdsburg Bypass has been completed to Lytton. Guy F. Atkinson Company was the contractor on this $2,354,000 unit which was opened to traffic last December.

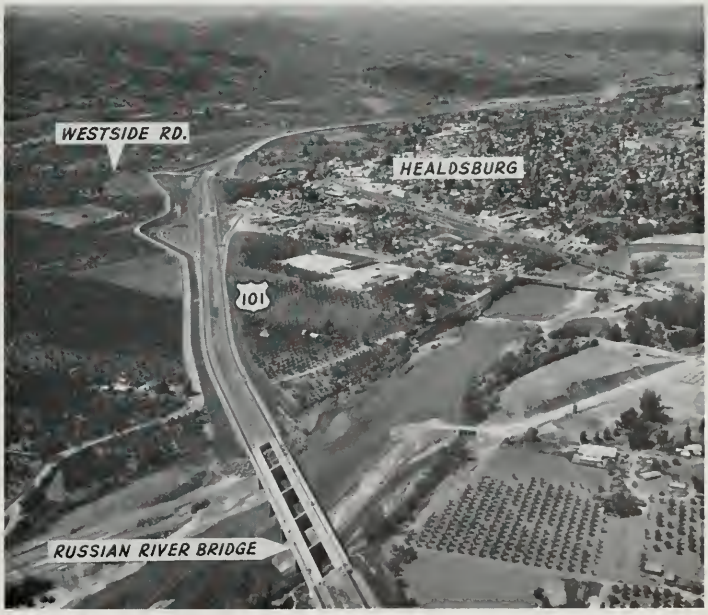
The route north of Lytton to the county line has been adopted. An initial four-lane, ultimate six-lane freeway is being planned for this 18½ miles.

U.S. 101 (Bypass)—San Francisco to Palo Alto (Bayshore Freeway)

Although 26 miles of continuous six-lane freeway has been in use between San Francisco and Palo Alto for several years, the congestion resulting from heavy peak hour traffic dictates further improvements. The



U.S. 101 south of the Healdsburg Bypass, looking southward, showing construction now under way.



The Healdsburg Bypass with the new twin bridges across the Russian River (foreground).

first of these, a widening project in the vicinity of San Francisco International Airport, was completed in April, 1961.

A fourth lane in each direction was added between Broadway in Burlingame and San Bruno Avenue in San Bruno. The added northbound lane begins at Peninsular Avenue. At the Millbrae Avenue interchange, a direct right-turn connection to the southbound freeway was added and remaining ramp outlets were improved. L. C. Smith Company was the contractor for this $1,662,000 project which included installation of a double blocked-out metal beam barrier between opposing traffic lanes through interchange areas.

The widening has provided considerable traffic relief in the vicinity of San Francisco International Airport and a reduction in travel time between Peninsula communities and San Francisco.

Also under way is a landscaping project between 16th Avenue in San Mateo and San Carlos. Approximately $71,300 is being expended to provide trees, shrubs and ground cover on the approaches to structures. A similar project was completed in July of last year between Harbor Boulevard in Redwood City and University Avenue in Menlo Park. Cost of this planting was approximately $194,000. Another $150,000 has been budgeted for landscaping the section between Spruce Avenue in Redwood City and University Avenue.

A $41,000 contract for the installation of cable-chain link median barrier was completed in December between Third Street in San Francisco and Sierra Point Overhead. Further extension of the barrier now being planned will provide 17 miles of cable-chain-link median barrier from Sierra Point to the Redwood Creek Bridge in Redwood City.

U.S. 101 (Bypass)—Palo Alto to San Jose (Bayshore Freeway)

Two contracts in Santa Clara County are expected to be completed in December, 1961, climaxing several years of intensive construction effort to provide a continuous freeway from San Jose to San Francisco.



The Bayshore Freeway (looking south) near the International Airport where a fourth lane in each direction has recently been completed.

The six-lane facility was extended southerly from the San Mateo County Line to Stierlin Road in Mountain View in May of last year. Interchanges were provided at Embarcadero, San Antonio and Middlefield Roads on this 4.4 mile, $3,391,000 project constructed by L. C. Smith and Concar Ranch and Enterprises.

During 1958 and 1959, interchanges were completed at Moffett Boulevard and at the intersection of U.S. 101 (Bypass) and State Sign Route 9 (Mountain View-Alviso Road). A contract connecting these interchanges and extending the freeway southerly to Fair Oaks Avenue is currently in progress. Interchanges are being constructed at Reingstorff Avenue, Stierlin Road, Ellis Street, Mathilda and North Mathilda Avenues. The work, being performed by L. C. Smith and Concar Ranch and Enterprises, includes construction of a freeway section on State Sign Route 9 from Bayshore Freeway to 0.2 mile east of Borregas Avenue.

Other features of this $4,518,000 contract are the improvement of existing channel facilities of the Santa Clara County Flood Control District and realignment and channel widening on Guadalupe River at the southerly end of the project. The cooperative project for the channel improvements provided a source of material for the freeway with channel right of way being furnished by the Flood Control District.

Allen M. Campbell Co. is constructing the last section of Bayshore Freeway in this area. This 6.1 mile contract provides a four-lane freeway between Brokaw Road and the future Guadalupe Parkway and six lanes from there to Morse Avenue where it joins the section mentioned above. This work, costing approximately $5,670,000, provides cloverleaf interchanges at Fair Oaks Boulevard, Lawrence Station Road, San Tomas Aquinas Boulevard and De La Cruz Boulevard.

Southerly of this portion, a contract was completed last May between Brokaw Road and Taylor Street in San Jose. Included in this $4,317,000 project was the extension of State Sign Route 17 as a freeway to First Street

in San Jose. Thirteen structures were built including those within the cloverleaf interchange at the intersections of Nimitz, Sign Route 17 and Bayshore Freeways. Interchanges were also provided at North First Street, existing Sign Route 17 and old Bayshore highway. These projects were discussed in detail in an article on San Jose Freeways in the July-August 1960 issue of this magazine.

Approximately 5,000 shrubs, 400 trees and ground cover were planted by Rudolph Watson between Coyote Creek and Santa Clara Street in San Jose at a cost of $65,000. Funds in the amount of $300,000 have been budgeted for extending landscaping north on Bayshore to Brokaw Road and for planting on Nimitz and Sign Route 17 Freeways between Bascom Avenue and old Bayshore Highway.

U.S. 101 (Bypass)—San Jose to U.S. 101 at Ford Road (Bayshore Freeway)

An expressway has been in operation within these limits since 1947. Design studies are now under way for conversion to an ultimate eight-lane freeway. Public meetings have been held and a freeway agreement has been executed with the City of San Jose for that portion of the highway within the city limits. Agreements with the county covering other portions are pending.

Funds in the amount of $850,000 are budgeted for grading, paving and structures at Tully Road. This project will provide a full four quadrant cloverleaf interchange with collector roads and is expected to be advertised this summer. Another project will add facilities for turning movements at the McKee Road interchange constructed in 1957.

U.S. 101 in San Francisco

Within San Francisco, U.S. 101 traverses city streets, the Central Freeway and portions of the James Lick Memorial and Southern Freeways. Construction and design activities, except for landscaping and minor projects, are confined at present to the Southern Freeway. Planning studies are currently under way by the City for reappraisal of the ultimate freeway system in San Francisco.



An aerial view of a capacity crowd at the San Francisco Giants' Candlestick Park, with the over-water section of the Bayshore Freeway curving south around Sierra Point toward South San Francisco and the Peninsula communities.

Work is in progress on repairing the expansion joint metal plates on the Marina Viaduct approaches to the Golden Gate Bridge. This $160,000 contract is being performed by the Independent Iron Works. Bids were opened April 26 for resurfacing Van Ness Avenue (U.S. 101) between Lombard Street and Golden Gate Avenue estimated to cost approximately $150,000.

Central Freeway

Two units of the Central Freeway have been open to traffic between James Lick Freeway and the vicinity of the Civic Center since April, 1959.

This past year, approximately 750 eucalyptus trees, 3,000 shrubs and 38,000 ivy plants were set out between Valencia and Turk Streets by A. S. Brown Landscaping Co. under a $72,300 contract.

James Lick Memorial Freeway

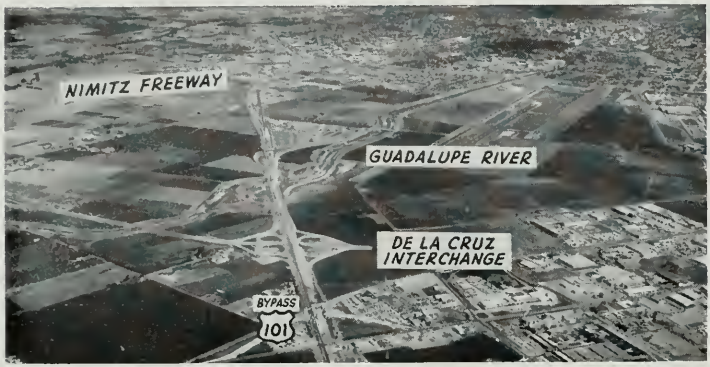
Work on this six and eight-lane freeway in the past few years has consisted of landscaping, erosion control, installation of median barriers and the construction of direct interchange connections to the Southern Freeway at Alemany Boulevard. Although part of U.S. 101 from the Division Street Distribution facilities to the Southern Freeway, James Lick Memorial Freeway extends from the San Francisco-Oakland Bay Bridge to the San Mateo County Line and is used by 150,000 vehicles a day.

Minor projects completed during the past year included resurfacing and reconstruction of curbs and gutters in the vicinity of Alemany Rotary interchange at a cost of approximately $20,600. A blocked-out metal beam median barrier was installed between Army Street and Third Street in two contracts at a total cost of approximately $100,000. An $11,700 landscaping project between the 18th Street and 22nd Street pedestrian overcrossings was also completed.

A project will soon be advertised for functional planting along a 1.35 mile section of James Lick Freeway between Paul Avenue Undercrossing and Powhatan Avenue just north of



Looking south along the Bayshore Freeway through San Jose.



Looking south toward San Jose from above the Bayshore Freeway under construction.



Bayshore Freeway construction in the Mountain View area with Moffett Field indicated (left foreground).

the Southern Freeway Interchange, for an estimated cost of $89,500.

Southern Freeway

The Southern Freeway extends westerly from the James Lick Memorial Freeway to a proposed connection with the future Junipero Serra Freeway in Daly City and forms a part of U.S. 101 to San Jose Avenue. The first unit was opened to traffic in July, 1960, when Guy F. Atkinson Co. completed a $7,565,000 interchange project at James Lick Freeway. Direct connections are provided for all turning movements and provision has been made for future freeway extension east and northerly to the Embarcadero Freeway. This contract, financed partly with $1,450,000 of city funds, included reconstruction of Bayshore Boulevard. The Highway Commission has under consideration a proposed routing for a future connection with the Embarcadero Freeway.

The second unit between Milton Street and the completed interchange, is being constructed by Charles L. Harney, Inc., with $4,273,000 allotted for providing 1.1 miles of six-lane, future eight-lane, freeway and structures to carry Alemany Boulevard traffic over the freeway in the vicinity of Gaven and Condon Streets. Mission Street and Justin Drive traffic will also be carried over the freeway. A temporary structure has been built to detour Mission Street traffic during construction and the city is participating in the cost of relocating a major sewer within the limits of the contract.

Funds have been budgeted for two additional units of the Southern Freeway and design studies are under way. A one and three-tenths mile, $6,000,000, project between Ocean Avenue and Mission Street will be advertised this summer. It is expected that the 1.8 mile section between Orizaba Avenue and Ocean Avenue, estimated to cost $4,600,000, will be ready for contract early next year.

Funds have been budgeted for a $188,300 landscaping project between Boylston Street and the James Lick Freeway and studies are in progress for additional landscaping.

U.S. 101—El Camino Real—San Francisco to Ford Road

Minor traffic signal, channelization, resurfacing and widening projects were completed during the past year at numerous locations along this arterial which links Peninsula communities. Approximately $191,000 was expended on eight projects which were financed in cooperation with the cities concerned.

A 1.2 mile contract in Daly City was typical. Approximately $94,500 was expended to remove the old street car tracks on Mission Street, construct a median island and install traffic signals. Daly City contributed approximately $7,400 and the City of San Francisco $12,600 for this work.

Portions of El Camino Real have previously been widened to six lanes with a median separation and funds have been budgeted for two additional projects. The City of Millbrae is contributing $140,000 as its share of a $385,000 project between Taylor Boulevard in Millbrae and Santa Helena Avenue in San Bruno. A 2.7 mile portion between Matadero Creek and University Avenue in Palo Alto will be widened to six lanes by a $1,330,000 project to which the City will contribute $440,000. Both of these projects will be advertised in the near future.

Design studies are under way for widening the portion northerly from Millwood Drive in San Bruno to Old Mission Road in Colma.

Public meetings have been held and plans established for widening 13.7 miles between Matadero Creek in Palo Alto and State Sign Route 17 in San Jose. Aerial photographs have been received for planning studies for an interchange at Page Mill Road in Palo Alto. Interchange studies have also been made at San Antonio Road in Mountain View. Construction of interchanges at the major crossings of U.S. 101 is contingent on substantial participation by local agencies.

Plans are being prepared for widening of the remaining three-lane section between Tully Road and Ford Road to a four-lane divided arterial. This five miles is the last remaining section of three-lane highway on U.S. 101 between San Francisco and Gilroy.

U.S. 101—El Camino Real—Ford Road to San Benito County Line

The route was adopted after Commission Hearing in February 1961, for an ultimate eight-lane freeway between Ford Road at the junction of Bayshore and El Camino Real and Thomas Road south of Gilroy. This proposed 25-mile facility will be located east of existing U.S. 101.

Minor interim projects are being constructed within these limits. During the past year, $25,000 was expended to provide left turn lanes at Church Street and Burnett Avenue in Morgan Hill. Funds in the amount of $220,000 have been budgeted for resurfacing and reconstructing an eight-mile section from Madrone Underpass in Morgan Hill to Coyote.

Since 1951, a four-lane divided expressway has been in operation south of Gilroy to the Pajaro River at the San Benito County line.

Embarcadero Freeway

The double-deck Embarcadero viaduct has been in service for two years from the Bay Bridge approaches around San Francisco's financial district to Broadway. Design studies are under way for access ramps to Clay and Washington Streets at an estimated cost of $1,470,000. Construction is to be correlated with widening of the city streets in order to properly



A frontage road beside the James Lick (Bayshore) Freeway in San Francisco showing ivy ground cover on slopes and shrubbery planting (left) to screen freeway lanes.



The Silver Avenue offramp beside the James Lick (Bayshore) Freeway in San Francisco, looking northeast at the three-level interchange for the Southern Freeway crossing. The interchange area has been landscaped with Scotch broom and ivy ground cover. Blocked out metal beam guard rail divides opposing traffic lanes on the freeway.

handle the ramp traffic as a part of the Golden Gateway Redevelopment project now in progress.

The California Highway Commission has under consideration the routing recommended by the San Francisco Board of Supervisors for the southerly extension of the Embarcadero Freeway between Howard Street and the Southern Freeway extension at Evans Avenue. Planning studies are also in progress for the Hunters Point Freeway extending from Evans Avenue to the Bayshore Freeway near the south city limits. The Southern and Embarcadero Freeway extensions are included in State Highway Route 253 added to the system by the 1959 session of the Legislature.

During the past year, parking lots and landscaping have been added under the viaduct. Another project, which received considerable attention was the $25,400 viewing area completed in January on the upper deck of the Embarcadero Freeway which provides pedestrian strolling areas and parking for 60 vehicles.

Funds have been budgeted for extending of the Southern Freeway easterly from James Lick Memorial Freeway to meet the proposed Embarcadero Freeway near Oakdale Avenue. This 0.7 mile section is estimated to cost approximately $5,500,000 and the City of San Francisco is acquiring the rights of way for the project in accordance with state law.

Junipero Serra Freeway (Interstate 280)

Detailed design studies are being made and rights-of-way are being acquired on this Interstate route down the Peninsula from San Francisco to connect with Sign Route 17 at Moorpark Avenue in San Jose. Fourteen projects are planned to complete this 47 miles of freeway. Interstate 280 follows Sign Route 17 to join Interstate 680 (Nimitz Freeway) at Bayshore in San Jose.

Eight lanes will be constructed between Alemany Boulevard in San Francisco and Eastmoor Avenue in Daly City. From Eastmoor Avenue to Woodside Road near Atherton, eight lanes will be built. Six lanes will be constructed initially on the remaining portion between Woodside Road and Sign Route 17.

Cabrillo Highway (Sign Route 1)—Watsonville to San Francisco

Planning studies have been completed for 5.2 miles of initial four-lane, ultimate six-lane freeway between Watsonville and Rob Roy Junction south of Aptos. Public hearings on this project are scheduled for this summer.

A $612,000 contract at Capitola is under way by L. C. Smith on the first of a series of projects to convert the existing expressway between Rob Roy Junction and Santa Cruz to full freeway. It includes construction of the 41st Avenue Interchange and a frontage road between South Rodeo Gulch and 17th Avenue.

North of Santa Cruz, construction of two lanes of a future four-lane expressway has been in progress for several years. Two such projects were completed during the past year, jointly financed by the State and the three counties of Santa Cruz, San Mateo and San Francisco under Joint Highway District No. 9. $844,000 was expended for 1.5 miles of two-lane roadway and 1.7 miles of four-lane expressway from Wilder Creek to 4.0 miles south of Davenport. Four-lane expressway was provided for passing in areas where the terrain creates sight distance problems.

A similar $393,000 project was constructed between New Years Creek near the Santa Cruz County line and Whitehouse Creek. These projects complete the work of Joint Highway District No. 9 which was established in 1928 for the purpose of building State Sign Route 1 between Santa Cruz and San Francisco.

Funds in the amount of $550,000 have been budgeted for an initial two-lane replacement of the Tunitas Creek Bridge and approaches. Design is complete and rights-of-way are being purchased for a future six-lane expansion.

Two hundred ten thousand dollars is budgeted for resurfacing portions of the 37 miles between Davenport and Princeton, south of Half Moon Bay.

Design studies are under way to provide a four-lane, ultimate six-lane facility from Half Moon Bay Airport to Skyline Boulevard in Daly City and thence to a junction with Junipero Serra Freeway. Included in this section is the conversion of the existing four-lane expressway between Manor Drive in Pacifica and Skyline Boulevard to a six-lane freeway and a relocation around the Devil's Slide area between Montara and Pacificia for which the freeway routing was established last December.

State Sign Route 1—North of San Francisco

Planning studies for relocation of Sign Route 1 between Manzanita at Richardson Bay, four miles north of Golden Gate Bridge, and Olema, were presented at public meetings. Further consideration of the route has been postponed pending legislative determinations regarding scenic highways.

Work performed during the past several years has consisted of reconstructing roadways and improving drainage facilities. Two such projects were completed in the last year. Nearly $100,000 was expended between Muir Beach and 5.3 miles south of Olema and $172,000 was spent to reconstruct and resurface portions of the existing two-lane highway between the Marin County Line and Bodega Bay. Construction has started on a $150,000 contract for grading and paving a 0.5 mile section north of Jenner. A 1.6 mile project to perform similar work north of Fort Ross has been planned.

Bay Front Freeway

Designated by the 1959 Legislature as State Highway Route 289, this route will be located east of the Bayshore Freeway, extending from San Jose to a connection with the future Hunters Point Freeway in San Francisco.

Approximately one and one half miles of the route across Brewer's Island at the westerly end of the San Mateo-Hayward Bridge has been adopted and geometric studies for the future interchange at the intersection with State Route 105 are under way. This section was established in order to enable planning to proceed in connection with development of Brewer's Island as a planned community.

Stevens Creek Freeway

Design studies are in progress for the new Stevens Creek Freeway between the Junipero Serra Freeway and Bayshore Freeway near Mountain View. The first unit will be a four-lane section 3.1 miles in length between the Junipero Serra Freeway south of Homestead Road in Cupertino and El Camino Real in Sunnyvale. The remaining 2.4 mile portion between El Camino Real and Bayshore Freeway is being designed on an initial four-lane, ultimate six-lane basis.

An interim four lane arterial project on State Sign Route 9 along the present Mathilda Avenue routing was completed in November from the Southern Pacific Railroad east of El Camino Real to an interchange at Bayshore Freeway in Sunnyvale. The cost of constructing two additional lanes and installing signals and lighting was $195,000. This section, for which the city purchased rights-of-way, will be relinquished to the city when the Stevens Creek freeway is completed.

The California Highway Commission has authorized development of the existing State Sign Route 9 to a four lane arterial between Azule north of



Construction on State Sign Route 1 between White House and New Year's Creek in San Mateo County.

Saratoga and El Camino Real in Sunnyvale. The County of Santa Clara will purchase the rights-of-way for this cooperative interim project.

Skyline Boulevard

State Sign Route 5 is a scenic, conventional two-lane highway following the crest of the coastal range between San Francisco and Sign Route 17 south of Los Gatos.

North from Ralston Avenue to Crystal Springs Road in San Bruno, the route will be developed as a part of the Junipero Serra Freeway. Design studies are under way for a $4,950,000 four-lane, future six-lane freeway between Crystal Springs Road and Cabrillo Highway (Sign Route 1) in Daly City. An expressway has been in service from Cabrillo Highway to Sloat Boulevard in San Francisco since 1956.

Sign Route 17—Santa Cruz to San Jose

Three major construction projects and several landscaping contracts were completed during the past year on this route linking the Bay Area communities with the recreation areas in and near Santa Cruz. Immediately north of Santa Cruz, a 3.3 mile section of four-lane expressway to Carbonera Creek near Glen Canyon Road was constructed by Frederickson and Watson Construction Co. Interchange facilities were constructed at Pasatiempo and frontage roads were provided on this $1,650,000 contract.

From Glen Canyon Road, the expressway is being extended northward three miles on new alignment at a cost of $1,288,000. This contract includes interchanges at Granite Creek and Glen Canyon and an overcrossing at Scott's Valley. The existing three-lane highway through Scott's Valley will continue to serve local traffic.

A two and one-half mile section of four-lane freeway was constructed between Bascom Avenue and North Fourth Street in San Jose at a cost of $3,212,000. This contract, together with a portion of SSR17 and interchanges constructed as a part of the Bayshore Freeway project through San Jose, completed the freeway from Los Gatos to Oakland in June, 1960. These and related projects in the San Jose area were described in detail in the July-August 1960 issue of *California Highways and Public Works.*

Landscaping between Roberts Road in Los Gatos and Bascom Avenue in San Jose was completed at a cost of $79,000. Approximately 2,300 redwoods, 1,000 shrubs and over 100,000 ivy plants were planted by Shawn Co. Another landscaping project, at Saratoga Avenue Interchange in Los Gatos, included redwood trees and approximately 8,000 shrubs planted by Rudolph Watson at a cost of $19,000.

Other completed contracts included paving portions of old Sign Route 17 between Bascom Avenue and Bayshore Freeway and a $226,000 reconstruction and resurfacing project between the Santa Cruz-Santa Clara



Looking north along State Sign Route 17 near Santa Cruz.

County line and 0.7 mile south of Black Road. Traffic signs, highway lighting and ramp widening and channelization are being constructed at the intersection of the freeway off-ramp with Camden Avenue in Campbell. The City of Campbell is contributing $11,700 to this $56,700 project.

Two hundred thousand dollars has been budgeted for another landscaping project between Bascom Avenue and Bayshore Freeway.

Nimitz Freeway (Sign Route 17)—San Jose to Oakland

Although a continuous freeway has been in service since 1958, additional lanes, interchange and separation facilities, and median barriers are being added.

Funds in the amount of $4,800,000 have been budgeted for adding two lanes to the existing six-lane section between Hegenberger Road and Fallon Street in Oakland. Median barriers, ramp revisions and the widening of overhead structures are included in this project, and the present left hand take-off at 42nd Avenue will be replaced by a right hand take-off.

Design is under way for extending the eight-laning from Hegenberger Road to the junction with Route 228 in San Leandro and for widening to six lanes from Route 228 to Jackson Street in Hayward. Studies are also in progress for converting separations to interchanges at Hacienda Avenue in Hayward and Stevenson Boulevard in Fremont and for expansion of the existing First Avenue Interchange to a full cloverleaf.

The City of San Leandro contributed $138,000 for the purchase of rights-of-way and for construction of approaches to the Floresta Boulevard Overcrossing which was completed in March of this year. Total project cost was $276,000. A cable-chain link barrier was constructed between Washington Avenue in San Leandro and 98th Avenue in Oakland, and blocked-out metal beam guard rail was constructed between 98th Avenue and High Street on a $206,000 contract. Blocked-out metal beam barrier was also installed between Fallon Street and the Cypress Street Viaduct in Oakland as a part of a $290,000 project which also included a similar installation on U.S. 40 north from the Distribution Structure to the El Cerrito Overhead.

Other projects completed were the planting of eucalyptus trees and shrubs on a $53,800 landscaping project between Linden Street and Fifth Avenue Overhead in Oakland and the placing of sidewalk railing fences on the First Avenue, Washington Avenue and Hacienda Avenue Overcrossings.

An additional $120,000 has been budgeted for landscaping 2.3 miles between Central Avenue and Thornton Avenue in Fremont.

Sign Route 17—U.S. 40 to U.S. 101

North of the Distribution Structure in Oakland to El Cerrito Overhead in Richmond, the route is part of U.S. 40 and work on this portion is discussed fully in the U.S. 40 section of this article. Although not yet programmed for construction, a $15,300,000 project is under design study to provide 6.2 miles of six-lane freeway between El Cerrito Overhead and Marine Street in Richmond near the easterly approach to the Richmond-San Rafael Bridge.

The westerly portion of the route, developed to freeway standards, has been open to traffic between the bridge and U.S. 101 in San Rafael since 1959.

During the past year, two channelization projects were completed with a combined cost of $96,000 in Richmond to allow efficient use of the existing facilities pending development to freeway standards.

Sign Route 21 (Interstate 680) Warm Springs to Martinez

Although a part of Interstate Route 680 utilizes State Sign Route 17 between San Jose and Warm Springs, State Sign Route 21 comprises the major portion of this route connecting the East Bay communities between San Jose and the Benicia-Martinez Bridge.

The route has been adopted between Warm Springs and U.S. 50 near Dublin and design studies are in progress. A 5.5 mile, $6,200,000 project between Mission San Jose and Scott's Corner at Sunol, presently budgeted, will substantially reduce the grade rate over Mission Pass. This project for a four-lane, ultimate six-lane freeway will be ready for advertising late this year.

An aerial mapping contract is now in progress on the 7.6 mile, portion between Scott's Corner and Dublin. On the portion between Danville and Walnut Creek, plans for a $13,500,000, 6.4 mile project will be completed this year. Contra Costa County is scheduled to contribute $500,000 towards improvement of county roads feeding this four lane facility. On the remaining 7.2 mile portion between Dublin and Danville, the route has been adopted and design is well advanced.

In the vicinity of Walnut Creek, 4.2 miles of four-lane and six-lane facility were constructed between Rudgear Road and the junction with Sign Route 24 near Oakland Boulevard. This $8,552,000 contract was written up in the May-June 1960 issue of *California Highways and Public Works*.

A low bid of $3,735,293 was submitted on April 12 on a 4.2 mile, $4,410,000 project for construction of an initial four, ultimate six-lane freeway from the new junction of Sign Route 24 near Willow Pass Road at Concord to the Arnold Industrial Highway north of Pacheco.

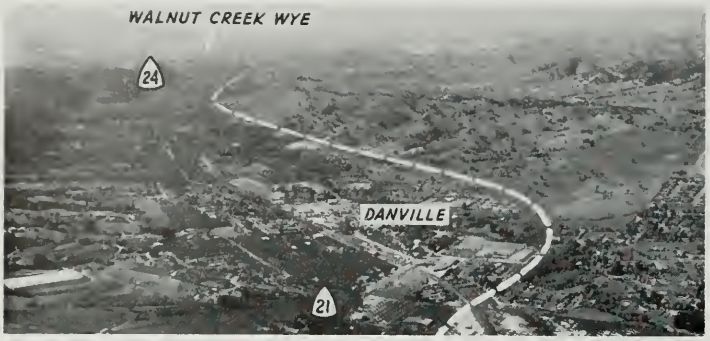
The project between the finished freeway at Monument Road and north of Concord Avenue is discussed in the next section of this article.

Peter Kiewit Sons Co. is constructing the approach to the Benicia-Martinez Bridge from State Sign Route 4. Three interchanges and two major railroad separations are included in this 3.9 mile $5,131,500 project. This project, with a connection to Escobar Street in Martinez, and the $14,240,000 bridge now under construction, are being financed from revenue bonds authorized by the Legislature in 1952.

Also under way is a landscaping project at the junction of Sign Routes 21 and 24 in the vicinity of Walnut Creek, on which $350,000 is being expended to plant 7,600 cedar, eucalyptus, pine, elm and redwood trees and a ground cover of 68,000 periwinkle plants.

Sign Route 24—Oakland to Sacramento County Line

Sign Route 24 begins at Ashby Avenue Interchange on the Eastshore



Looking north along existing Sign Route 21 showing Danville in the center. Dotted line shows adopted alignment for future construction.



Looking northward along Sign Route 21 from the Alameda-Contra Costa County line toward Danville. The adopted route which generally follows the existing highway is indicated by the dotted white line.



San Ramon Village, looking north from above Dublin Boulevard along existing State Sign Route 21 in Contra Costa County. Adopted routing is indicated by the dotted white line.

Freeway (U.S. 40), proceeds easterly through the Caldecott Tunnel to Walnut Creek, Concord and via the Antioch Bridge to Sacramento.

A related series of six projects are under way in design to provide a direct connection from the Nimitz Freeway to Sign Route 24 and the Caldecott Tunnel. This connection, a portion of which is known as the Grove-Shafter Freeway, will provide 7.1 miles of eight lane freeway at a cost of approximately $37,565,000. Major interchange facilities will be provided at Nimitz, MacArthur and Warren Freeways. Plans are being coordinated with rapid transit studies in this area.

An additional 2-lane tunnel paralleling the two existing Caldecott Tunnels is now being constructed by Connelly-Pacific Co., Grafe-Callahan Construction Co., Brayer Electric Co. and Charles L. Harney, Inc. A more detailed description of this $12,500,000 project is given in the July-August 1960 issue of this magazine.

Completion of the new bore is expected in the late summer of 1963. Alternating the direction of travel in the center bore will provide four lanes to accommodate morning and evening peak traffic and facilitate maintenance operations during off peak hours.

A $7,500,000 project will be advertised this fall to construct 2 miles of eight lane freeway from the east portal of Caldecott Tunnel to the completed freeway at Orinda.

North of Walnut Creek, a 2 mile freeway extension from the completed section at Monument Road will fill the gap in the Interstate Routing between Walnut Creek and the Martinez-Benicia Bridge and will include grading on Sign Route 24 to Concord Avenue. Plans for this initial four-lane freeway are complete and ready for advertising as soon as aqueduct relocation of the Mokelumne lines of the East Bay Municipal Utilities District can be completed. Design studies are under way for the 3.5 mile portion between Concord Avenue and Sign Route 4.

Route 10S—San Mateo and Alameda Counties

The first contract for freeway development of this route between Half

Moon Bay on the San Mateo Coast and High Street in Oakland via the San Mateo-Hayward Bridge will be advertised this summer. This 2.3 mile portion between West Hillsdale Boulevard and South Delaware Street in San Mateo will cost approximately $4,800,000. Four lanes will be provided initially with an ultimate six-lane freeway planned for the section between El Camino Real and South Delaware Street. Two additional projects extending to Junipero Serra Freeway on the west and to the San Mateo-Hayward Bridge on the east are being designed.

Plans for reconstructing and widening the San Mateo-Hayward Bridge to four lanes are being made by the Division of San Francisco Bay Toll Crossings and preliminary work is already under contract. A $3,000,000 project to provide 3.4 miles of initial four-lane freeway between the easterly approach and Nimitz Freeway is also being designed.

East of Nimitz Freeway, planning studies are well along for freeway development in conjunction with Route 105 and 259 to U.S. 50 near Castro Valley. An interim project for improvement of the existing route along Jackson Street between Harder Road and Castro Street in Hayward will be advertised this summer. Improvement of this 1.6 miles as a conventional four-lane divided highway will cost approximately $2,255,000 and includes a $200,000 contribution to the Alameda County Flood Control District for construction of a dam on Ward Creek in conjunction with the project to eliminate flooding of the highway.

Other interim projects included channelizations and installations of traffic signals and a new bridge across San Lorenzo Creek in the vicinity of Mattox Road and East 14th Street in Hayward. The U.S. Corps of Engineers, Alameda County, and the Alameda County Flood Control District participated in the cost of this $287,000 project.

North of Jackson Street, Route 105 traverses the city street system of Hayward, San Leandro and Oakland.

Route 107—San Gregorio to Sunol

Minor improvements at both ends of the Dumbarton Bridge to widen the roadbed were accomplished during the past year in two contracts totaling $266,000 and studies are in progress for the grading and paving of an improved westerly toll plaza.

The route has been adopted and surveys are being made for a future 5.7 mile $6,500,000 freeway between Dumbarton Road in Newark and State Sign Route 9 in the Centerville area of Fremont. As a part of this project, two lanes will be constructed initially easterly to Lincoln Avenue in Newark, with four lanes on the remaining portion.

Preliminary meetings have been held and project studies are being made on a 13 mile section between Junipero Serra Freeway south of Woodside and the westerly end of the Dumbarton Bridge.

A $95,000 interim project for widening and shoulder improvement between Main Street and Sign Route 9 in Fremont was advertised in April. A project for resurfacing between Mission Boulevard in Fremont and Sunol, and a line change in Woodside to avoid a slipout have been financed for early construction.



The east portal of the Caldecott Tunnel on Sign Route 24 between Oakland and Walnut Creek. Grading is in progress for the additional two-lane bore to be constructed at the right of the existing tunnel.

Mountain View—Milpitas Area

Presently under construction in conjunction with work on the Bayshore Freeway is the initial four-lane development of Sign Route 9 from Bayshore to east of Borregas Avenue, including an interchange at North Mathilda Avenue.

On a 2.3 mile project to construct the northerly 2-lanes of a future four-lane freeway between east of San Jose-Alviso Road and Nimitz Freeway, a low bid of $367,270 was submitted on April 19. This project includes a new Coyote Creek Bridge to replace the present narrow structure with a modern 2-lane bridge on improved alignment.

Design studies are under way for further development of the entire portion between Bayshore and Nimitz freeways.

Route 5—San Jose to Hayward

Project studies are in various stages of progress on the proposed freeway between Bayshore Freeway near Story Road in San Jose and the MacArthur Freeway in Hayward. A California Highway Commission hearing was held April 14, 1961 for the 12.5 mile



Area to be traversed by the 19th Avenue Freeway (dotted line) from the San Mateo-Hayward Bridge (background) and Junipero Serra Freeway (foreground).

portion of the Foothill Freeway between MacArthur Freeway and Washington Boulevard in Fremont and early adoption of the route is anticipated.

An interim widening contract recently completed provides an 80 foot roadbed with 16 foot concrete medians and left turn lanes on Foothill Boulevard between Sycamore Avenue and Gresel Street in Hayward. Traffic signals are also included in this $761,000 project.

Route 108—Sunol to Livermore

The route for an initial four-lane, future six-lane freeway within these limits was adopted November 12, 1960. An interim project to revise the grade and change the alignment between Alden Lane and El Caminito in Livermore, to be jointly financed by the State and Alameda County, is under design study.

Webster Street Tube and Route 226

The contract under way for construction of the second two-lane tube and approaches between Oakland and Alameda is expected to be completed in the fall of next year. Six sections of a total of twelve sections were cast and the first section was sunk into place in April, 1961. A more comprehensive report on this project was printed in the January-February 1961 issue of *California Highways and Public Works Magazine*.

In connection with the tube contract, $360,000 is being expended to place a heavy rock blanket over the existing Posey Tube to prevent displacement. Another $460,000 has been provided for a recently advertised contract to grade and pave storage areas to replace those acquired from the Alameda Army Medical Depot. One other project, to revise lighting and entrances to the existing Posey Tube, will be let when the opening of the new tube permits the temporary closing of Posey Tube for such work.

Warren Freeway (Mountain Boulevard)

Mountain Boulevard was originally developed by Joint Highway District No. 26 which was dissolved in 1954. Since that time, the City of Oakland and Alameda County have each contributed $150,000 per year to match State funds for the development of this four-lane, ultimate six-lane freeway from SSR 24 near Lake Temescal to a connection with the MacArthur Freeway near Mills College.

Funds in the amount of $50,000 have been budgeted for landscaping portions between Broadway Terrace and Redwood Road. Construction is financed for a $700,000 interchange at Moraga Avenue and plans are under way on the remaining $1,500,000 freeway section between Redwood Road and MacArthur Freeway.

Shepherd Canyon Freeway (Route 235)

The route has been adopted and design studies are in progress on the 10.4 mile portion between Warren Boulevard at Park Boulevard Interchange and Sign Route 24 at Pleasant Hill Interchange. Rights of way are being acquired on this initial four-lane, future six-lane freeway. During the 1959 legislative session, Route 235 was extended to provide a continuous route from the Nimitz Freeway near 42nd Avenue to Sign Route 21 near Concord.

Arnold Industrial Freeway (Sign Route 4)

The route for this major east-west freeway in Contra Costa County between U.S. 40 and State Sign Route 21 was adopted in October 1958. The interchange with U.S. 40 near Hercules and a short relocation were completed in 1959 in connection with construction on U.S. 40.

Plans are well advanced for a 4.8 mile portion from Cummings Skyway to East Alhambra Avenue in Martinez. Design is also under way for the projects between U.S. 40 and Cummings Skyway and from East Alhambra Avenue to Willow Pass Road north of Concord.

A contract was awarded recently for the construction of the interchange at the intersection of Sign Routes 4 and 21 near Concord as a part of the freeway construction on SR 21.

From Willow Pass Road to Neroly Road east of Antioch, Sign Routes 4 and 24 are identical. Design studies

are under way for a project within these limits to replace existing grade intersections with interchanges at Bailey Road and Somersville Road. Design of the section from A Street in Antioch to the Antioch Bridge is in progress and rights of way are being acquired.

A $29,000 contract for landscaping the Railroad Avenue Interchange in Pittsburg was completed last year.

Sign Route 37 (Ignacio Wye to Sign Route 128)

Plans for development of the existing 4-lane expressway to a future full freeway status are under way between U.S. 101 at Ignacio Wye and Sears Point, and between the Sonoma-Napa County line and Imola Avenue in Napa.

Between Sears Point and the Sonoma-Napa County line, studies are in progress for a future six-lane freeway.

A $66,400 project for grading and paving portions of the conventional 2-lane highway between 3 miles and 12 miles northeast of Napa was awarded in April of this year. The County is contributing $16,000 for this work.

Sign Route 29 (Vallejo to Lake County Line)

Two projects are presently under construction in the City of Napa. On one, $372,000 is being expended to construct the Sonoma Road Overcrossing with approaches and frontage roads. The second contract ties in with the first and provides an interchange at Imola Avenue and a one mile section of four-lane freeway between the two structures. The County of Napa is contributing $61,000 to the $1,031,000 second project for improvement of drainage in the adjoining area.

From Old Sonoma Road to Union Station, plans are being prepared for three projects to develop an existing expressway to a full freeway. Rights of way are now being acquired.

North of the completed expressway at Orchard Avenue, two projects are being designed to provide a four-lane expressway as far north as Rutherford. The initial two lanes of the section bypassing Yountville were completed in 1959. The route from Rutherford to Ritchie Creek, north of St. Helena was adopted in September 1960.

South of Napa, rights of way are being acquired for development to a six-lane freeway from Imola Avenue to the Solano County line.

Sign Route 12 (Jenner to Napa Junction)

Plans for the first unit of the 17.8 mile four-lane freeway between Sebastopol and Kenwood are nearing completion. This 4.0 mile project between West Occidental Road and South E Street in Santa Rosa is estimated to cost $5,500,000. An interim project is being prepared to provide a four-lane divided section between Farmers Lane and Brush Creek. The City of Santa Rosa will provide the rights of way for this $156,000 project.

Design studies are under way for five projects to complete the freeway between Sebastopol and Kenwood.

On the westerly end of this route $156,600 was expended last year in the vicinity of Monte Rio for rock slope protection and slipout correction. Funds in the amount of $600,000 have been budgeted for a conventional 2-lane highway on relocation between Duncan Mills and Austin Creek, including a new structure across Austin Creek and elimination of the narrow, steep Duncan Mills grade.

Summary

The past year has seen continued progress toward the realization of a basic freeway network in the San Francisco Bay Area. A broader look at the present freeway picture shows a completed freeway from Los Gatos to the Carquinez Bridge and from Orinda through Walnut Creek. The final link of the Bayshore Freeway between San Francisco to south of San Jose is under construction as is the last section of continuous freeway-expressway from the Golden Gate Bridge to north of Healdsburg.

The twin virtues of safety and beauty continue to play major roles in freeway design and development. The past year has witnessed some 20 projects providing a wide range of functional and aesthetic planting.

Another change has been the appearance of nearly 20 miles of experi-



Chain link fence along the south side of the Old Sonoma Road Overcrossing at Sign Route 29 in the Napa Valley serves both as a railing for the pedestrian walkway and as a deterrent to children dropping objects on cars passing beneath the structure.

mental median barriers on heavily traveled freeways on both sides of the bay. Two types have been used; one utilizes specially mounted metal guard rails and the other consists of steel cables and chain link fence. These reduce headlight glare and virtually eliminate hazard of head-on crashes caused by crossing over the divider. New signs and pavement markings are appearing on some 450 off-ramps to minimize chances of entering freeway lanes in the wrong direction.

The influence of Interstate Highway standards can be seen on all sides; green background for directional signs and mileage markers, the distinctive Interstate Route signs, and the first portions of yellow center stripes.

These changes, superimposed on the growing freeway pattern, reflect and form an integral part of the immensely larger transformation taking place in the Bay Area.

STATUS OF DISTRICT IV FREEWAY AND EXPRESSWAY PROJECTS

April 1961

Description	Total miles	Completed projects		Under contract		Budgeted		Right of Way expended and budgeted
		Miles	Construction cost	Miles	Construction cost	Miles	Construction cost	
U.S. 101 AND 101 BYPASS								
Bayshore and James Lick Memorial Freeway, U.S. 101 Bypass; Southern Freeway in San Francisco to Ford Road South of San Jose	52.9	41.4	$48,052,000	11.5	[a]8,673,000		$1,475,000	$25,019,045
Southern Freeway (Incl. Route 253 Ext.)	4.7		[b]7,312,000	1.1	4,072,000	3.1	16,288,000	18,425,370
James Lick Memorial Freeway	3.0	3.0	11,438,000					12,870,444
Central Freeway	1.8	1.8	11,587,000					8,552,000
Golden Gate Freeway	1.1					1.1	5,100,000	70,197
Ford Road South of San Jose to San Benito County Line	27.9	5.8	1,093,000					545,839
Redwood Freeway; Golden Gate Bridge to Mendocino County Line	84.3	55.9	[c]41,583,000	14.9	9,363,000		700,000	16,656,043
U.S. 40								
San Francisco to Carquinez Bridge (portions)	18.2	18.2	[d]61,103,000				319,000	13,222,690
U.S. 50								
MacArthur Freeway; Distribution Structure to Castro Valley	15.3			4.5	16,571,000	6.5	16,700,000	50,337,592
Castro Valley to San Joaquin County Line	31.4	31.4	11,647,000					4,135,000
SIGN ROUTE 17								
Nimitz Freeway; Distribution Structure to Bayshore Freeway at San Jose	41.3	41.3	55,452,000	Add lanes	4,942,000		120,000	22,075,416
Santa Cruz to San Jose (portions)	19.9	17.0	15,783,000	2.9	1,288,000		200,000	9,933,016
U.S. 40 near Albany to U.S. 101 near San Rafael (portions)	9.9	2.4	1,973,000					2,390,775
SIGN ROUTE 9 AND 21								
Warm Springs to U.S. 50	17.7					4.7	6,200,000	793,175
U.S. 50 to Walnut Creek	16.0	3.5	2,910,000		100,000			8,079,441
Walnut Creek to Monument	3.4	3.4	9,104,000		132,000			6,417,774
Monument to Solano County Line	7.4			3.2	[e]6,833,000	4.2	6,210,000	3,531,620
Sign Route 9 North of Route 21 in Fremont	2.2							10,000
GROVE-SHAFTER FREEWAY AND SIGN ROUTE 24								
Sign Route 17 in Oakland to Warren Boulevard	4.8							5,961,751
Warren Boulevard to Walnut Creek	11.0	6.8	9,606,000	1.1	11,703,000	2.0	7,500,000	5,492,582
North of Monument to Sign Route 4, Concord	3.4		226,000				500,000	1,675,321
EMBARCADERO FREEWAY	1.5	1.5	14,792,000					12,284,683
PARK-PRESIDIO FREEWAY; GOLDEN GATE BRIDGE TO FULTON STREET	2.1	1.2	1,448,000					70,000
JUNIPERO SERRA FREEWAY								
Sign Route 17 to San Francisco County Line	43.9							14,096,432
Stevens Creek-West Valley Freeways	23.6							3,614,335
CABRILLO HIGHWAY								
Moss Beach to Lake Merced Boulevard in San Francisco	17.0	5.4	2,766,000					6,307,015
Watsonville to 4 miles South of Davenport (portions)	22.8	12.4	6,929,000				612,000	3,678,068
JUNIPERO SERRA FREEWAY TO NIMITZ FREEWAY								
19th Avenue Freeway, Junipero Serra Freeway to Alameda County Line at San Mateo Bridge (portions)	8.0					4.9	4,800,000	3,533,895
San Mateo County Line to Nimitz Freeway	6.8							450,000

STATUS OF DISTRICT IV FREEWAY AND EXPRESSWAY PROJECTS—Continued

April 1961

Description	Total miles	Completed projects		Under contract		Budgeted		Right of Way expended and budgeted
		Miles	Construction cost	Miles	Construction cost	Miles	Construction cost	
Pacheco Pass: 1 Mile East of Bell's Station to Merced County Line	5.3	5.3	1,285,000					12,393
West of U.S. 101 to Bypass U.S. 101 in Redwood City (Route 214)	1.1							1,700,000
Mountain View—Alviso Freeway; El Camino to Nimitz Freeway	10.5	2.1	1,006,000	0.9	674,000		360,000	1,247,087
Freeway Connection from Nimitz Freeway to U.S. 50 (Route 228)	2.2	2.2	2,803,000					2,236,000
Bay Farm Island Bridge and Approaches	0.6	0.6	2,062,000					165,000
Webster Street Tube	1.1		203,000	1.1	17,363,000		300,000	3,176,725
Warren Boulevard Freeway: Sign Route 24 near Lake Temescal to MacArthur Freeway	5.6	4.1	[f]5,612,000				550,000	2,043,488
Shepherd Canyon Freeway; Warren Boulevard Freeway to Sign Route 24	10.3							625,963
Arnold Industrial Freeway; Hercules to Antioch Bridge (Sign Routes 4 and 24)	34.1	14.7	4,694,000					1,833,955
Sign Route 12; Sebastopol to Kenwood	17.7							5,375,036
Sign Route 29; Solano County Line to Calistoga	36.9	22.2	3,472,000		372,000		670,000	3,186,157
Sign Route 37; From Redwood Freeway at Ignacio to Napa	13.4	7.2	5,900,000			0.5	300,000	1,205,902
Totals	642.1	310.8	341,841,000	41.2	82,086,000	27.0	68,904,000	283,037,225

(a) Includes $300,000 contributed by cooperating agencies.
(b) Includes total of $1,600,000 by City of San Francisco.
(c) Includes total of $5,000,000 by Golden Gate Bridge and Highway District.
(d) $29,117,000 Toll Bridge Funds in this amount.
(e) $6,833,000 from Toll Bridge Funds.
(f) City of Oakland and Alameda County contributions included in this figure.

BIDS WILL BE OPENED JULY 11, ON SAN MATEO-HAYWARD BRIDGE TRESTLE

The State Division of San Francisco Bay Toll Crossings has advertised for bids on the construction of four and one-half miles of four-lane concrete trestle to replace the easterly portion of the present two-lane San Mateo-Hayward Bridge.

The work will be the second major stage in the bridge widening project. Construction of a mole fill at the eastern approach to the bridge has been under way since early in April.

Approximately $19,000,000 in bridge toll revenue funds is available for the concrete trestle work, according to Norman C. Raab, chief of the Division of San Francisco Bay Toll Crossings.

Bids will be opened July 11 at 2 p.m. in the Division's office, 151 Fremont Street, San Francisco.

The four-lane concrete trestle will traverse the non-navigable portion of San Francisco Bay. It will be at the same low height above the water as the present trestle, and immediately adjacent to it along the north side. Raab explained that the type of steel structure which will be used over the navigational channel, near the westerly shore, has not been finally determined, but that the trestle work is designed to tie in with any type.

The contract will provide for completion of the trestle section in about two and a half years.

Plans call for construction of a two-lane trestle along the north side of the present structure, for removal of the present substandard structure, and then construction of a new two-lane trestle in its place. The construction work will be phased, Raab said, so as to provide four lanes of travel for increasing distances as the job progresses westward.

Total length of the San Mateo-Hayward Bridge is about seven miles.

The Legislature now has under consideration a bill which would authorize a high level fixed-span structure over the navigable portion of the bay in place of the present low-level lift span.

CANADIANS STUDY RIGHT-OF-WAY PROCEDURES



Members of Parliament of the Province of Ontario and staff members visited Sacramento early in May for conferences with State Division of Highways and Department of Public Works officials on right-of-way procedures, laws and policies. Seated at the table (left to right) are S. E. Fennell, Special Counsel to the Committee; A. R. Dick, Chief of the Ontario Department of Highways Legal Section; A. Grossman, Member of the Provincial Parliament and Minister Without Portfolio; William G. Naden, Member of the Provincial Parliament; Fred M. Cass, Minister of Highways and Chairman of the Delegation; Leo Troy, Member of the Provincial Parliament; Hollis E. Beckett, Queen's Counsel; George W. Parry, Charles E. Jones, Gordon W. Innes, and Joseph M. Gould, all Members of the Provincial Parliament; and T. Fred Bogshaw, Assistant State Director of Public Works. Seated away from the table in the left background are (left to right) Harry Fenton and Robert E. Reed, Assistant Chief and Chief of the California Division of Contracts and Rights-of-Way; J. W. Trask, Deputy State Highway Engineer; Harold Barry, Superintendent of Property, Ontario Highway Department and Ellis P. Morningstar, Member of the Provincial Parliament. Standing are J. C. Womack, State Highway Engineer and Robert B. Bradford, State Director of Public Works.

FEDERAL-AID HIGHWAY CONTRACTS TOTAL 7,098 IN CALENDAR YEAR 1960

A total of 7,098 Federal-aid highway and bridge construction contracts was awarded by the State highway departments during 1960, involving a total cost of $3.1 billion. The figures were compiled by the Bureau of Public Roads, U. S. Department of Commerce. The dollar volume of these contracts represents almost a 25-percent increase over the comparable 1959 figure of $2.5 billion.

The contracts awarded in 1960 averaged about $440,000, with the median size about $160,000. They varied from less than $25,000 to over $16 million, with an equitable distribution throughout the entire range. Twenty-six percent of the Federal-aid highway and bridge construction contracts awarded by the State highway departments were for amounts less than $50,000, and 17 percent were between $50,000 and $100,000. Another 22 percent were for amounts between $100,000 and $250,000, and 15 percent were between $250,000 and $500,000.

About 79 percent of the total number of contracts awarded were for amounts less than $500,000 and better than 42 percent were for amounts less than $100,000, indicating that a large proportion of the Federal-aid contracts awarded in 1960 were sized for small business. The Federal-aid highway program thus appears to be favorable to the existence and prosperity of both large and small contractors. This is in consonance with the declaration by Congress in Federal-aid legislation that it is in the national interest both to encourage and develop the actual and potential capacity of small business in connection with the prosecution of the highway program.

A tabulation of the contract figures follows. Included among the contracts are 695 for miscellaneous specialty projects, such as seeding, signing, or lighting, most of which are included in the two lowest sized groups.

U.S. 80 - San Diego

Another Eight-lane Section is Completed

By MARK E. DARROUGH, Highway Engineering Associate



With the completion of another major U.S. 80 freeway contract through the Mission Valley area of the city of San Diego on December 23, 1960, another major step was taken toward the culmination of a six-year freeway construction effort to place in operation a major transportation complex with westerly terminus at U.S. 101 in the city of San Diego and extending to the easterly end of the El Cajon Valley, a distance of 17 miles.

This 3½-mile, eight-lane freeway section of the National System of Interstate and Defense Highways extends easterly from the U.S. 80/U.S. 395 interchange to Fairmount Avenue and was constructed by the R. E. Hazard Contracting Company and W. F. Maxwell Company at a cost of approximately $4,500,000.

In addition to the full eight-lane facility, the work also included construction of frontage roads on each side of the freeway; interchanges at East Cabrillo, Texas Street, and Ward Road; and two parallel two-lane bridges over the San Diego River, which join the county's Murphy Canyon Road.

Two-phase Construction

The freeway was constructed basically in longitudinal halves. The new westbound lanes were constructed first while traffic utilized the existing facility. Upon completion of the new westbound lanes, traffic was shifted thereon and the new eastbound lanes were constructed on approximately the same alignment as the old roadbed. This basic plan of construction has been mandatory on a majority of the freeway contracts on U.S. 80, inasmuch as the new construction has substantially followed the old alignment



The El Cabrilla Overcrossing on U.S. 80 in San Diego. The view is eastward.



Looking eastward on U.S. 80 showing Morena Boulevard (overcrossing and bridge foreground) and Taylor Street (joining U.S. 80 from the right).

and no alternate routes were available. This not only has required the use of the basic half-width construction plan but has caused extensive staging and phasing of construction operations and some curtailment of operations during certain peak traffic periods in order that the traveling public would be subject to a very minimum of delay during the construction period.

In addition to handling heavy volumes of through traffic, it was also necessary to phase all operations so that moderately heavy volumes of traffic on major intersecting city streets could be handled efficiently and with a minimum of delay during construction. In short, almost every freeway contract on U.S. 80 has been completely geared, construction-wise, to the needs of the traveling public, and at no time could any alteration in staging or phasing be made in construction operations until it was determined that public traffic would be equally or better served by the change.

Last Section

The aforementioned 3½-mile freeway contract was the last to be constructed, but roughly in the geographical center, of the seven freeway contracts which comprise the first ten miles of this U.S. 80 development which extends from U.S. 101 on the west to the city of La Mesa on the east. The six other contracts, in their geographical order, which comprise this ten-mile section of the complex, are as follows:

The first extended from U.S. 101 to U.S. 395, totaled 1.3 miles of eight-lane freeway, and was constructed by R. E. Hazard Contracting Company and W. F. Maxwell Company at a cost of $1,300,000. One overcrossing structure was built at the westerly end of the project at Presidio Park and frontage roads were constructed on each side of the freeway.

The second contract entailed extensive revision of the existing U.S. 80/U.S. 395 interchange to provide for full eight-lane construction for U.S. 395 as well as U.S. 80. This work was performed by the Griffith Company at a cost of $3,500,000.

The third contract was the three-and-a-half-mile, eight-lane section previously referred to.

The fourth contract encompassed the construction of an interchange at the intersection of a major city street, Fairmount Avenue. This one-mile section of six-lane freeway was constructed by the Griffith Company.

Fifth Contract

The fifth contract, also a six-lane freeway constructed by the Griffith Company, extended from Fairmount Avenue to 1.1 mile west of 70th Street. Interchanges were constructed at Waring Road and College Avenue, which are major city streets serving growing residential areas and commercial developments.

The sixth contract, again a Griffith Company project of six-lane design, extended from 1.1 mile west of 70th Street to 0.6 mile west of Fletcher Parkway. A city arterial also, 70th Street (Lake Murray Boulevard) was integrated into the freeway improvement by the construction of a major interchange at this intersection.

The seventh contract served to terminate the first ten-mile section of freeway into an interchange connection of U.S. 80 and the County-constructed Fletcher Parkway in the vicinity of La Mesa.

These ten miles are the backbone of a highly important transportation system connecting several city and county arterials. These arterials extend both north and south from U.S. 80 freeway interchanges into the major residential and commercial areas of East San Diego and the city of La Mesa, including the mushrooming new residential developments within these areas and the major industrial areas of Kearny Mesa and Mission Valley.

Evidence of Importance

The importance of this freeway section is evidenced by the six- to eight-lane construction, the 60,000-vehicle average daily traffic, and is further evidenced by the rapid improvement of major city and county intersecting highways to four-lane freeway or expressway standards.

Recently completed improvement on major city arterials which connect a majority of the East San Diego area to the U.S. 80 freeway and adjacent commercial developments, are as follows:

Texas Street was realigned and widened to three lanes between Adams Avenue and U.S. 80.

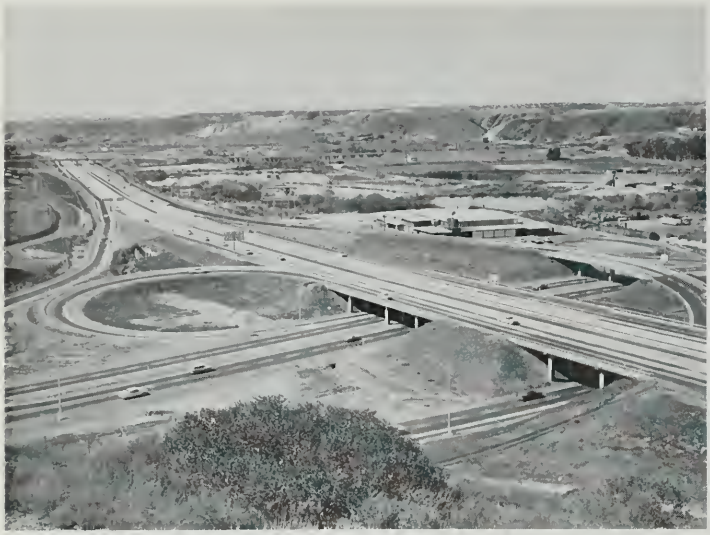
A major improvement was made from U.S. 80 south to Madison Avenue on Ward Road. The original



BEFORE. An aerial view at the Ward Road-U.S. 80 intersection taken in 1955.



AFTER. The new Ward Raad-U.S. 80 freeway interchange, vintage 1961.



The Fairmount Avenue-U.S. 80 interchange, looking northwest.

winding two-lane road was completely reconstructed into a four-lane full freeway and designed for possible expansion to six lanes.

Fairmount Avenue was also given the full freeway treatment between U.S. 80 and Monroe Avenue, plus the improvement of the easterly bearing Montezuma Road to four lanes divided and the construction of an interchange at the Fairmount-Montezuma intersection.

Waring Road, College Avenue, and 70th Street were all improved in alignment and grade and reconstructed to multi-lane freeway, or expressway standards.

First Major Expressway

While the City of San Diego has been concerned, in the main, with improvements south of U.S. 80, the County of San Diego has had the responsibility of a majority of the major roadway improvements to the north. In fact, the County was the first to complete a major expressway which ties into this east-west arterial, namely, the Fletcher Parkway, which intersects U.S. 80 at an interchange at the easterly end of this ten-mile freeway section.

At present the County has under contract the reconstruction of Murphy Canyon Road between U.S. 80 and U.S. 395. The work is being done by the Daley Corporation and when completed will provide a four-lane expressway connection between the Kearny Mesa industrial area adjacent to U.S. 395 and U.S. 80 at the Ward Road interchange.

The newly completed freeway section does not appear to be limited to serving only existing centers of residential population and commercial and industrial development, however. It is quite evident that it is becoming the nucleus around which extensive retail and commercial expansion is forming.

Many motels and restaurants have been constructed westerly of the U.S. 80/U.S. 395 interchange, and development along U.S. 80 easterly of this intersection has been pioneered by major commercial development in the vicinity of the Texas Street, College Avenue, and Fairmount Avenue interchanges, while large shopping centers have appeared in Mission Valley and at Grossmont. In addition, many other large developments are still in the planning stages.

Four Contracts

The remaining seven miles of this 17-mile interstate freeway are divided into four construction contracts, the last of which is scheduled for completion in February 1962. One of these contracts has already been completed and is located in the Grossmont Summit area. This project included an interchange tie-in between U.S. 80 and State Sign Route 67 and, at the easterly end of the project, began the initial departure from the old existing alignment and commenced the relocation of U.S. 80 to the western slopes of El Cajon Valley.

The next two contracts, one of which has just been completed and the other scheduled to be completed by mid-1961, will further extend the six-lane relocation of U.S. 80 along the western slopes of the valley and thence bypass the main business district of El Cajon to the north and terminate at Third Avenue in El Cajon—the end of this 17-mile 29-million-dollar freeway project.

The last contract to be completed, and out of geographic sequence, is located between the previously completed projects at 70th Street and at Grossmont Summit. This 2.3-mile project is scheduled for completion early in 1962 and calls for partial reconstruction of the U.S. 80-Fletcher Parkway interchange and the construction of an interchange connection to El Cajon Boulevard, another major La Mesa city artery.

Upon completion of this final contract, the entire 17 miles of freeway transportation complex will then commence operating as a composite unit and will, with the necessary assistance of improved city and county thoroughfares, serve all adjoining areas from U.S. 101 and Kearny Mesa through Mission Valley and Alvarado Canyon to eastern El Cajon Valley.

63 BIDS ADVERTISED

During April the Department advertised for bids on 63 highway projects with an estimated value of $31,797,800. Since January 1, 1961, projects for $131,876,200 have been advertised. There were 55 contracts awarded during the month.

During April bids were opened for 49 projects for which 296 contractors' bids were received, an average of six bidders per project.

U.S. 199 Tunnel

Work Begins on Relocation Of North State Highway

By PAUL E. PARKER and H. L. PAYNE, Senior Bridge Engineers



CONSTRUCTION of the new mountain tunnel on highway U.S. 199 at Hazelview Summit, between Crescent City and Grants Pass, Oregon, has now begun. The contractors are The Grafe-Callahan Co. of Los Angeles and the resident engineer is George Jochim.

This tunnel, which is estimated to cost $3,788,000, exclusive of approaches, makes possible the 4.3 mile highway relocation described by L. R. Redden in the September-October, 1960, issue of *California Highways and Public Works*. The new highway replaces a steep narrow road with eight hairpin curves. The new alignment pierces Hazelview Summit Ridge 340 feet below its crest with a sixty mile an hour alignment that has a six percent maximum grade. An elevation view of the tunnel is shown in the accompanying illustration.



Driving of the pilat bore at the narth portal of the new Hazelview Tunnel, part of a realignment project on U.S. 199 in Del Norte County.

Tunnel Description

The tunnel is 1886 feet long, provides two traffic lanes, and is 26 feet between curbs, with two 2′-4″ sidewalks. A 15-foot vertical clearance is provided for traffic. This 15-foot clearance is maintained at the portals with timber grade beams which ensure that high loads will not brush the lighting fixtures that run along each edge of the ceiling.

The bore is on a straight alignment. This is an advantage in tunnel construction and was achieved at some expense in the approach grading work. A horizontal curve that ends just ahead of the south portal carries some superelevation into the tunnel, and the tunnel arch is warped upward there to maintain adequate vertical clearances with a minimum typical section in the remainder of the bore. This warping upward of the arch saved about $32,000 compared to the alternative of using a larger tunnel cross section.

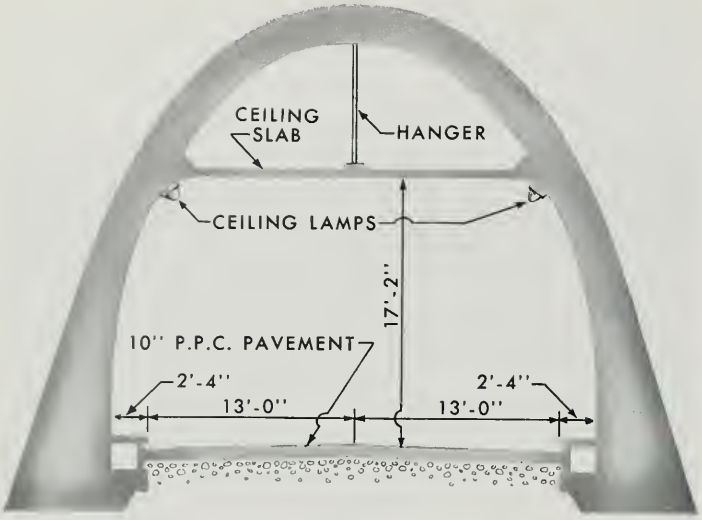
The roadway is on a straight grade of three percent, draining towards the north portal. This grade was selected by a study that took account of minimum desirable truck speeds on the uphill grade. The three percent grade also aids tunnel drainage during construction and operation.

Lighting is conventional, using a single continuous line of fluorescent tube fixtures along one side of the tunnel and a second line on the opposite side near each portal. The lighting design will provide illumination of 45 foot candles at the portal zones and 7 foot candles in the tunnel interior during daylight hours. Nighttime illumination will provide 1.7 foot candles throughout the tunnel and street light illumination beyond the portals.

Light Is Reflected

Reflection of light in the tunnel will be aided by a white epoxy paint applied to the walls and ceiling. The gloss surface provided by the paint film will also aid washing. The use of paint on the walls and ceiling rather than ceramic tile was estimated to save about $175,000 in initial cost, and should provide adequate service at this site.

An automatic mechanical ventilating system is also being installed. At first it appeared that the moderate tunnel length, combined with the light initial traffic volume, might allow dependence on natural drafts for ventilation. However a long term barometric pressure and wind direction data needed for reliance on natural ventilation were lacking at this site. This, coupled with the estimate that future traffic growth would defi-



SECTION
HAZELVIEW SUMMIT TUNNEL

nitely require mechanical ventilation, prompted the decision to install a ventilating system during initial construction.

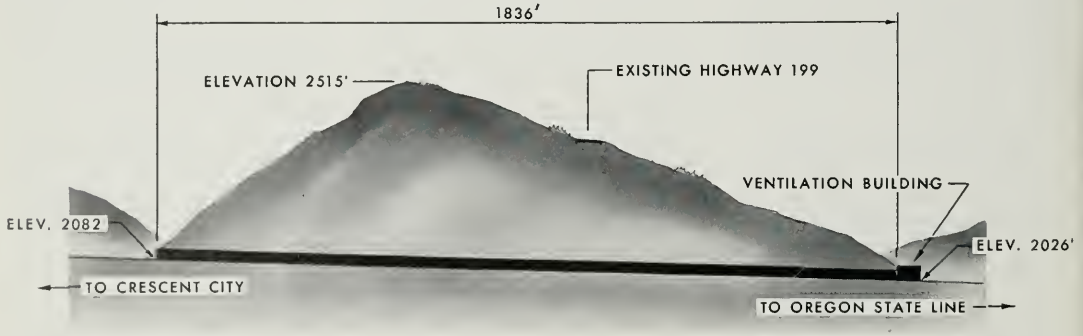
The ventilating system admits fresh air through the portals of the tunnel, and draws exhaust air through ceiling ports into a longitudinal duct running above the roadway for the length of the tunnel. The ceiling ports are arranged to provide varying exhaust capacity along the length of the bore, with the most exhaust capacity at the north end of the tunnel in anticipation of eventual conversion of the tunnel to one-way traffic. Exhaust air in the ceiling duct is withdrawn by propeller type fans into vertical stacks in the ventilation building at the north end of the tunnel. The fans are designed to exhaust 180,000 cubic feet per minute and maintain the carbon monoxide content of air in the tunnel below 4 parts in 10,000. The fans are actuated by recording carbon monoxide analyzers that continually sample air from four points in the tunnel. The system is designed to operate automatically with a minimum of maintenance.

Structural Design

The structural design of a tunnel depends on the character of the ground it penetrates. This tunnel penetrates highly folded, partly metamorphosed rock. It consists mostly of thinly bedded slaty shale, siltstone, and interbedded fine sandstone that is generally crushed and shattered. The beds have a steep dip, and trend in the same general direction as the tunnel. This is generally poor ground for tunneling.

The concrete liner selected to support the loading generated by this rock is an approximately parabolic arch, standing thirty-two feet high and 30'-8" wide at the spring line, shown in the accompanying illustration. The maximum design load on the arch was determined to be 100 feet of overburden, using Terzaghi's criteria. When the ratio of lateral pressure to vertical pressure is one to three the arch stresses are entirel axial and the maximum concrete stress is 655 psi, a low value. The arch is also reinforced to support in bending various conditions of unsymmetrical loading at design stress. Additional overload capacity is also available when the resistance of the walls of the tunnel to outward displacement comes into play.

The concrete liner is supported on wide footings that exert a maximum pressure on the foundations of twelve



PROFILE
HAZELVIEW SUMMIT TUNNEL

tons per square foot. If soft spots are encountered or horizontal squeezing occurs, a concrete strut slab is provided that can operate to carry both vertical loads and horizontal thrusts. The footing block is also designed to act as a continuous beam when it stands alone in the side drifts during the first stages of tunnel excavation.

One Liner Design

Only one liner design is provided for this tunnel. In many tunnels two or more designs, with different thicknesses for different ground and loading conditions, are used. In this case, it was determined that the simplicity of a single pattern for excavation, placing of structural supports, reinforcement, and concrete more than outweighed possible saving that might be realized by varying the liner design.

Encased in the concrete liner are structural steel arches called tunnel sets which support the tunnel roof between the time the tunnel is excavated and the time the concrete liner is poured. Steel tunnel sets of various strengths were designed as part of the contract plans. The Contractor is given the responsibility for providing adequate support and also the right to redesign the sets to best fit his operating methods and the ground conditions actually encountered.

Water seepage is always an important concern in highway tunnels, and considerable effort is made to provide adequate drainage here. Water seeping down through the rock towards the tunnel will encounter drainage holes drilled into the rock at about fifteen foot centers around and along the arch. Water that may penetrate the concrete liner in the upper part of the tunnel will fall onto the ventilation duct floor slab, which will have a waterproof surface and a drainage system. Water from these drains will be collected in longitudinal flumes lying below the sidewalks. Seepage water coming up from the floor of the tunnel will be drained through a blanket of filter material to longitudinal perforated pipe drains that lie below the pavement base course.

The structural design also considers snow and ice loadings. The ventilation building roof is designed to support the load of six feet of snow, the maximum snow depth recorded at the site. The ventilation duct floor slab likewise will support the ice load that would come upon it should the ceiling drains freeze.



Looking northeast along the completed rough grade of the north approach to the Hozelview Tunnel. North portal of the tunnel is hidden by the trees (left center). The big fill is across Broken Kettle Creek.

Construction Controls

Challenging problems also were presented by the time sequence of the contracts involved in construction of the project. Three major contracts are involved: roadwork north of the tunnel, the tunnel itself, and roadwork south of the tunnel combined with paving of the entire project. These contracts were overlapped to avoid an unreasonably long construction period.

The roadwork contract south of the tunnel was synchronized with the tunnel contract. At the south portal the tunnel daylights into a roadway cut, never reaching the original ground surface. Accordingly, the approach contract will require that the south portal be excavated before the tunnel contractor reaches it with his full-section tunnel excavation.

Assuming that the tunnel contractor would begin excavating from the north portal to take advantage of the gravity drainage in the tunnel provided by the roadway grade, and esti-



This northward view of the relocation of U.S. 199 shows the present highway and some of the clearing work being done on the new alignment.

mating that only one heading would be worked, sufficient space was left in the embankments of the north roadway contract to take all of the tunnel spoil.

The tight schedule also required letting the tunnel structure to contract before the tunnel mechanical and electrical work had been detailed. The tunnel mechanical and electrical work, except for items embedded in the tunnel lining, will be let as a separate contract that will overlap the tunnel structural work and be completed at the same time.

Future Outlook

An outstanding characteristic of tunnel work is the persistent difference between the prediction of underground conditions and the actual conditions encountered during construction. This characteristic exists because even the best underground exploration program gives only a rough indication of the character of the ground. Excavation is just beginning at this tunnel, and major difficulties have yet to present themselves. The story of the construction of this tunnel will be presented in a future article.

Division Asks Bids On U.S. 50 Freeway

The State Division of Highways has called for bids on a major freeway project on U.S. 50 in El Dorado County.

The project involves grading and surfacing to construct 2.8 miles of four-lane freeway on U.S. 50 between four-tenths mile west of Perks Corner and Placerville.

A total of $3,200,000 in state highway funds is available for the project.

The project includes construction of a bridge over Webber Creek and interchange structures at the El Dorado County Fairgrounds and west of Canal Street in Placerville.

Much of the new freeway will be on more direct alignment south of the existing route. Resurfacing of the existing highway is included in the project.

This project and another current job will complete seven miles of four-lane freeway and expressway through Placerville.

Construction Costs Maintain Stability

The California Highway Construction Cost Index for the first quarter of 1961 stands at 229.6, an increase of 1.1 index points or 0.5 percent over the fourth quarter of 1960. This small increase, together with the small fluctuations during 1960, continues to reflect the period of stability in prices which started during the last quarter of 1959.

Bidder competition during the first quarter of 1961, with an average of 6.1 bidders per project, is almost unchanged from the previous quarter (6.2).

The trend toward stabilization in highway costs is also indicated by the Bureau of Public Roads Composite Mile Index, which is based on Federal-Aid highway construction contracts awarded by the State highway departments. For the fourth quarter of 1960, the latest available, it now stands at 224.4, a decrease of 2.7 points or 1.2 percent. This index has shown small fluctuations during the past year.

The Engineering News-Record Construction Cost Index for the first quarter of 1961 also increased slightly and now stands at 344.8, an increase of 1.8 points or 0.5 percent over the previous quarter.

The annual average of the Engineering News-Record Index reflecting the cost of basic material and labor, has increased 13.8 percent in the last three years, while the Bureau of Public Roads Composite Mile Index has dropped 5.5 percent and the California Highway Construction Cost Index has dropped 12.0 percent during the same period, evidence of continued improvement in equipment and construction methods and also continued strong competition in the highway construction field.

The California Highway Commission has allocated $300,000 for slide removal and installation of a culvert on U.S. Highway 101 adjacent to Long Valley Creek about two miles north of Longvale in Mendocino County.

NASH TO HEADQUARTERS; FOLEY, SHERVINGTON NAMED

The transfer of District Engineer A. M. Nash of District V, California Division of Highways, to a special assignment in Sacramento Headquarters office and the transfer of District Engineer E. R. Foley from District IX, Bishop, to replace Nash at San Luis Obispo were announced by State Highway Engineer J. C. Womack. Womack also announced the promotion of Charles A. Shervington of Eureka to succeed Foley.

Nash has been in charge of District V since February, 1956. He has been with the Division of Highways for 41 years.



A. M. Nash

Womack said that Nash's special assignment will involve a statewide study to develop detailed information concerning engineering costs, engineering productivity and uniformity of engineering methods as applied to the Division's planning and construction program. The assignment is expected to last for 12 to 18 months. His position carries the newly established title of Systems Research Engineer.

"The purpose of this study," Womack added, "is to produce more highway for the taxpayer's dollar through the greatest possible uniformity in engineering methods and keeping engineering costs at a minimum. Part of the study has been made, but we have not been able to complete it in view of the heavy and increasing workload in all our departments.



E. R. Foley

"We are fortunate in having been able to persuade 'Pete' Nash to postpone his scheduled retirement date to do this job. He has been selected for this assignment because of his long and varied experience and proven ability."

In the course of his 41 years with the Division of Highways, Nash has worked in four of the Division's 11 districts, serving as District Engineer in three of them (Eureka, Marysville, San Luis Obispo), in addition to three tours of duty in Headquarters office in Sacramento. From 1946 to 1949 he was Engineer of Design for the Division.

Nash is a native of Elk City, Kansas, was educated in Idaho and Washington and at the University of Washington. During World War I he served as a second lieutenant in the Army Aviation Service. He joined the Division of Highways in 1920 as a draftsman and computer.

Nash is a past vice president of the Western Association of State Highway Officials and has served on important national committees concerned with highway design and construction.

Foley, who was appointed District Engineer at Bishop in June, 1956, has been with the Division since his graduation in civil engineering from the University of California in 1932, except for four years with the Seabees during World War II. He is a native of Nevada City.



C. A. Shervington

Most of Foley's early career with the Division of Highways was in bridge construction work. From 1950 to 1956 he was in charge of the statewide county road inventory and mapping program which the State carried on in cooperation with the various counties.

Foley is a member of the American Society of Civil Engineers and of the Rotary Club. He is a commander in the U.S. Naval Reserve. He has also been active in Boy Scout work. He and his wife, Josephine, have two children, Dennis, age 15, and Lynn, age 12.

He will report to District V on May 8 and assume charge of the district effective May 12.

Shervington has had 30 years of service with the Division of Highways, all of it with District I, which covers northwestern California with headquarters at Eureka. He started as a draftsman and rose through the ranks to become Assistant District Engineer in charge of planning in 1951. He has served in this position until his current promotion.

He was born in London, England, moved soon thereafter to Canada, and grew up in Oakland, where he attended the Polytechnic College of Engineering. During World War II he served in the Pacific with the U.S. Naval Reserve Civil Engineer Corps.

Shervington is a registered civil engineer. He is a Mason, and has been active in P.T.A. and Boy Scout work. He and his wife, Wilma, have two sons, Robert, age 13, and Bruce, age 11.

Shervington will report to District IX on May 1 and assume charge of the District effective May 5.

Womack Elected W.A.S.H.O. Head

State Highway Engineer J. C. Womack of California is the new president of the Western Association of State Highway Officials, it was announced May 5 on his return from the association's 40th annual meeting.

Womack moved up from the vice-presidency of the organization, which is composed of the highway departments of 14 western states, including Hawaii and Alaska.

He will serve until the next annual meeting, which will be held in Seattle, Washington, in June, 1962.

Other officers for 1961-62 are W. O. Wright, State Highway Engineer of Nevada, vice-president; and Forrest Cooper, Deputy State Highway Engineer of Oregon, re-elected secretary-treasurer.

The 1961 meeting was held in Las Vegas, Nevada.

$33,812,485 TO CITIES

A record total of $33,812,485 in State gasoline tax revenues has been apportioned to the 372 incorporated cities in California for city street work during the past fiscal year, it has been announced by State Highway Engineer J. C. Womack.

Interchanges

Spacing, Design Must Be Individually Tailored

By W. L. WARREN, Engineer of Design

In laying out a freeway system, the location of interchanges is a problem which, more than any other, must be solved jointly by the State and local jurisdictions involved, because the freeway interchange is where the two systems come together.

This article was first presented as a paper by the author before the Street and Highway Conference, Institute of Transportation and Traffic Engineering, University of California, held in January at Berkeley.

It is obvious that no trip either begins or ends on a freeway, and the motorist does not care and may not even know which jurisdiction is responsible for any particular choice of road he uses in making a given trip. Since the common objective of both freeways and conventional roads is to provide facilities for traffic, it is necessary to arrive at a satisfactory joint solution where two jurisdictions meet.

The construction of the California Freeway and Expressway System must be superimposed over a vast network of existing city streets and county roads. Certainly the State system will affect the other road systems and the other road systems will affect the design of the State system.

Spacing Important

Such an integrated system of city, county and state facilities depends largely on the proper location and design of interchanges for its success.

It is therefore important that interchanges be spaced at an optimum distance, taking into consideration the needs of the city and county road systems and the free flow and safety of traffic on the freeway. This can only be accomplished through the mutual cooperation of the State, cities and counties involved.

The high degree of cooperation and the helpful attitude of the cities and counties throughout California has made possible the orderly development of the highway construction program. I believe that this is an example of intergovernmental relationship in which we can all take some pride.

With the great Interstate Highway program which the Federal government now has under way, the U.S. Bureau of Public Roads has, of necessity, been a participant in the intergovernmental relationship involved in interchange locations. The cooperation and helpful attitude of the Bureau of Public Roads is something that the Division of Highways may be more aware of than the city or county governments. Representatives of the State and Federal governments are constantly working out the problems of interchange location involving the Federal government with the State, the cities and counties.

Legislative Action

The California Legislature has laid the ground work for a successful road system in California through recognition and understanding of the overall problem. Sound legislation has provided a workable and continuing program. In the enactment of this legislation, recognition has been given to the need for cooperation between the various governmental agencies when freeways are planned.

The Streets and Highways Code states that no city street or county highway may be closed by the construction of a freeway except pursuant to a freeway agreement between the Department of Public Works and the local jurisdiction. This requires full recognition of the local road systems.

It is in this area that complete agreement must be reached as to the location of interchanges and separations, and the necessary relocation of existing and construction of new local roads.

The statutes also provide for recognition of the freeway routes adopted by the California Highway Commission. In essence, the law states that no new city street or new county road may be connected to a freeway without the Commission's consent. In other words, only those local roads in actual existence at the time of freeway route adoption may be considered for connection to the freeway during design.

Connections Requested

Where freeway planning is well ahead of community development, it is often necessary for the city or county involved to request new connections to freeways. This allows for recognition of the community needs after a freeway route is adopted, if a satisfactory showing can be made to the Highway Commission.

These new connections to freeways become interchanges and their location must be consistent with spacing of adjacent interchanges.

The instructions for completing the estimate of cost for the Interstate System in accordance with Section 104(b)5, Title 23, U. S. Code, Highways, states in part:

"It is important that interchanges be located so as to properly discharge and receive traffic from other Interstate and Federal-aid system routes, or major arterial highways or streets. It is equally important that they not be spaced so closely as either to unnecessarily increase the cost of the system or interfere with the free flow and safety of traffic on the Interstate System.

"Interchanges within urban areas should not be spaced closer than an average of two miles, in the suburban sections of urban areas average not closer than four miles, and in rural sections average not closer than eight miles.

"Obviously, however, in consideration of the varying nature of the high-

way, street or road systems with which the Interstate System must connect, the spacings between individual adjacent interchanges must vary considerably. In urban areas the minimum distance between interchanges should not be less than one mile, and in rural areas not less than three miles. Under normal circumstances the increased cost of construction resulting from the development of an interchange should have a net benefit-cost ratio of not less than 1.0."

While interchange spacing less than that outlined is sometimes permitted on the Interstate System, adequate justification must be presented to and approved by the Bureau of Public Roads for each deviation from the minimum spacing mentioned.

Visit By Committee

In 1959 the "Special Freeway Study and Analysis Committee" of the American Association of State Highway Officials visited California. This committee was composed of engineers representing a cross section of the United States, and they said this about interchanges, spacing and location:

"The committee drew the conclusion that spacing of interchanges is not an initial design criterion but a determination of design to fit traffic needs."

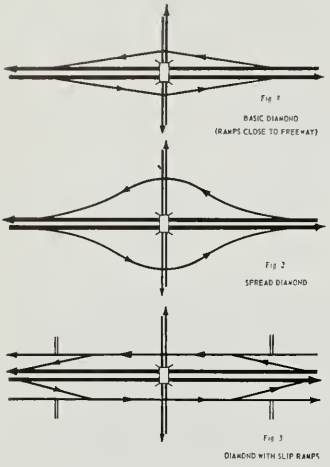
The committee also said:

"A freeway interchange in a rural area should be located where the traffic needs indicate justification



A typical portion of a constructed freeway through a metropolitan area, in this case U.S. 40 through Richmond. To provide adequate traffic service to commercial, industrial and residential areas, many streets must be served to and from the freeway. This illustrates the need for proper planning since the design of one interchange is dependent upon the design and proximity of adjacent interchanges.

PLATE 1



therefor. The resulting spacing may be few or many miles. The same element of justification applied to urban areas must be further supplemented by the need to assure proper circulation of traffic on the arterial and local streets of the city affected by traffic turning to and from the freeway. To do otherwise might concentrate interchange traffic at one or a few locations in such volumes that serious disruption of traffic on both the local streets and the freeway can result.

"Distribution among several streets rather than concentration on one or two would seem to be preferable, provided (1) space is available and conditions are amenable for proper design of the interchange turning roadways, (2) sufficient length is available along the freeway for proper entrances and exits, (3) sufficient length is available along the freeway for installing signing and marking for smooth and proper traffic operation and (4) sufficient length is available for effecting needed transition between freeway and street operation, and accommodating traffic destined for or coming from the freeway on adequate local facilities."

Here we have differing approaches to the problem. The one approach is to establish a minimum spacing of interchanges in rural and urban areas as an initial design criterion while recognizing special cases. The other is to work out interchange spacing as justified independently of land use with the spacing varying perhaps widely.

Purposes Outlined

There are two basic purposes for freeway interchanges: the first, to transfer local traffic to and from the freeway and local road system, and the other for a freeway to freeway type of traffic interchange. In general, no local connections can be permitted to freeway to freeway interchanges due to the conflict that would be introduced.

In urban areas the primary considerations are *traffic operation* and *capacity*. The problem of distribution of freeway traffic to and from the local street network without creating bottlenecks on either the freeway or the local street intersections is difficult and should be the major consideration when interchange location is being determined.

On the other hand, in rural areas where capacity is not a problem, it is only necessary to balance local traffic service against reasonable cost. Numerical warrants for interchanges have not been developed. Warrants therefore are necessarily general and must be based on engineering judgment. It suffices to say that sufficient interchanges are required in rural areas for proper traffic circulation and area development.

To a great extent the location of interchanges is controlled by the location of the freeway in relation to the local road pattern.

For example, the construction of a freeway along an existing highway or expressway almost invariably results in many more interchanges than if the freeway were on entirely new location. Since the freeway absorbs the local service facilities, it must take over the job of this facility as well as serving through traffic.

Conversely, a freeway on an entirely new location does not usually have to consider local traffic service to as great an extent as long as separations are provided at reasonable intervals to allow the existing road pattern to be maintained.

Connection Problem

Where existing towns are by-passed, every effort is made to provide rather direct service to and from the freeway. However, a direct type of connection to the existing highway into a town must sometimes be compromised by the need to connect other local roads at the same interchange, and by the existence of railroads, expensive improvements, or other topographic controls.

In both rural and urban areas the overall community interest must be considered. A traffic interchange or series of traffic interchanges on a freeway through a community may affect the traffic pattern of large contiguous areas. It follows that the location and spacing of interchanges will be affected by the size of the city and the type of area.

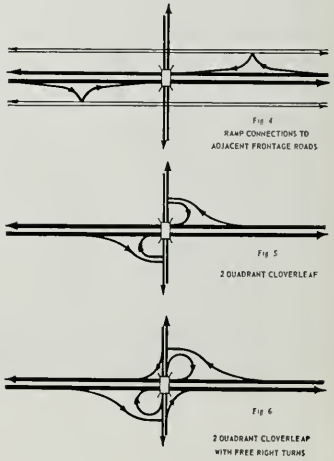
The existence of traffic generators such as large industrial or commercial areas will also affect interchange location and spacing. The core area or business district of a community may require an unusual number of interchanges and ramps to insure the proper operation of traffic on the freeway and adjacent streets.

Master planning of roads and streets must also be considered, to insure that future traffic patterns will be integrated.

Other Factors

There are other factors which, in varying degree, must also be considered, but these factors must not be permitted to lead to heavy expendi-

PLATE 2



tures for freeways which are not properly planned for traffic.

Highway funds must be expended in such a manner as to provide the most service to all traffic without compromising the quality of the service to the main segments of traffic. Since freeway travel is faster, cheaper and safer than travel on conventional highways, it is commensurate with this policy to convert as much conventional highway travel as possible to freeway travel. This is only possible through an adequate number of interchanges.

Although a spot economic analysis may often seem to warrant an interchange, an item of, say, $500,000 in capital outlay must be resolved by experience and judgment in respect to the overall picture in completion or extension of the freeway system.

To summarize:

Planning for interchanges must consider city streets, county roads and State highways as an integrated system and the needs of all these systems must be considered.

Interchanges cannot be so far apart as to concentrate large volumes of traffic at ramps, or so far apart as to entail unreasonable circuitry for off-freeway traffic. Nor can they be spaced so close together as to cause conflict with each other due to lack of weaving and acceleration distances.

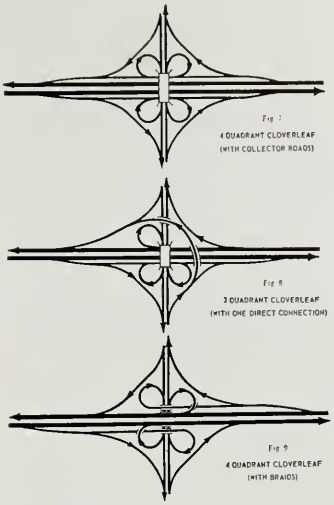
Optimum Spacing Varies

Optimum spacing of interchanges may vary widely under various circumstances. In the interest of construction economy, a minimum number of interchanges is desirable; nevertheless, there are no satisfactory predetermined criteria of spacing.

The principal consideration is traffic service and traffic safety weighed against cost.

Within this broad limit there is a great deal of latitude. The following examples may illustrate this:

From east of Baker to the Nevada State Line, a distance of 48 miles, six interchanges or an average of one in eight miles are planned or constructed. However, on the same route, on the bypass of Baker itself, approximately two miles in length, it is necessary for proper traffic service to provide a direct connection at each end of the



community and an interchange in the middle—or three interchanges in two miles.

On a project just west of Santa Barbara through an area of developing subdivisions, five interchanges are being provided in an 8½ mile project or approximately one every 1¾ miles.

On U.S. 40 between the American River north of Sacramento and Auburn, a distance of 30 miles, 27 interchanges are provided. Individual spacings vary, however, from a minimum of 2,400 feet to a maximum of over two miles.

Between Lodi and Sacramento on U.S. 99, a distance of 25 miles, there are 17 interchanges.

In urban areas such as Los Angeles, the spacing is fairly close. For example, the Hollywood Freeway from the 4 level structure to Vineland Boulevard, a distance of 9½ miles, has 16 interchanges—an average interchange spacing of six-tenths of a mile.

The Bayshore Freeway from near the Bay Bridge in San Francisco to Moffett Field, a length of 36 miles, has 36 interchanges.

Obviously, when all considerations are carefully weighed, the spacing may vary widely from project to project or interchange to interchange.

Types of Interchanges

Like other features of freeways, interchange design has evolved through the years, so that present-day interchanges are sometimes different from those of 10 or 15 years ago.

There are probably few places in the field of engineering where there is such room for originality and free thinking on the part of the designer. There are probably few cases, too, where each element of design is so costly and where each element can produce user saving of such magnitude.

Considerable time is devoted to interchange design in both the District offices and Headquarters office of the Division of Highways. The various designs developed are sometimes displayed like paintings in a gallery. The basis of judging, unlike that used for paintings, must be the more mundane factors of construction costs, right of way costs, adaptability to signing and user benefits.

Traffic Cost Considered

In design, each interchange presents an individual problem, for it must be considered in conjunction with adjacent interchanges, and the project as a whole. The choice of interchange type is dependent on many factors, but primary considerations are traffic and cost. Cost is made up of both construction and right of way costs, and traffic considers not only traffic volumes but also user costs.

The diamond interchange with ramps close to the freeway shown in Figure 1 might properly be considered the most basic interchange type. In one sense, other interchange types are modifications of this design to fit specific conditions.

The tight diamond design is most appropriate when the freeway is either depressed or elevated with the cross road remaining at natural ground. This condition is often found in metropolitan areas where the freeway must be separated from many cross streets.

If the freeway is depressed, good sight distance is provided on both the off-ramps and the cross road. If, however, the freeway is elevated, sight distances are somewhat restricted; and, where prevailing conditions allow, the ramp intersections on the cross road should be moved away from the freeway. Because of prohibitive right of

way costs, many of these tight diamond interchanges have been constructed in large metropolitan areas. These interchanges have satisfactorily handled large traffic volumes when the intersections are signalized and the cross roads have sufficient capacity.

Spread-diamond Type

The spread diamond type of interchange shown in Figure 2 is usually found in rural areas where the freeway is in the vicinity of natural ground and the cross road is raised over the freeway. The ramp intersections on the cross road are moved outward from the freeway to improve sight distance. The distance that these intersections may be moved away from the freeway must often be compromised with consideration to local improvements, right of way costs and the proximity of frontage roads.

The spread diamond interchange would also be appropriate when the freeway is in the vicinity of natural ground and the cross road is depressed. This combination of elevations is seldom resorted to, since it lacks flexibility of stage development on the cross road and is usually expensive.

The diamond type interchange with slip ramps into one-way street patterns is shown in Figure 3. This design is often appropriate when parallel frontage roads are so close to the freeway that additional intersections cannot be provided on the cross road. Sufficient weaving distance must be provided on the frontage road for local and ramp traffic if this type of interchange is to function properly. The condition where slip ramps enter the frontage road at the intersection with a cross street should be avoided since undesirable weaves will occur.

Parallel Frontage Roads

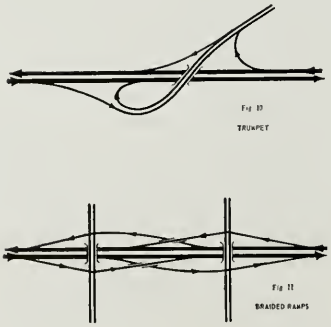
There are many examples where an interchange type with ramps connecting to parallel frontage roads, as shown in Figure 4, may prove appropriate. The ramps provided by this type of design are often referred to as "hook ramps". To minimize this hooked effect, the designer should provide the best standards of alignment feasible, with special emphasis given to the off-ramps. Sufficient deceleration distance should be provided between the loop radius and the off-ramp nose to minimize the tendency to overdrive the curve.

In the general case, this type of interchange results in poor standards of alignment for the ramps and presents additional conflicts for traffic destined to the cross road. Sight distance, however, is usually good, which may account in part for the use of this interchange type in rural areas where the cross road is carried over the freeway and sight distance would be restricted if a tight diamond (Figure 1) were provided. In built-up metropolitan areas, this hook ramp design may be the only feasible type because of high right of way costs and nearby parallel frontage roads.

The two-quadrant cloverleaf design shown in Figure 5 is a type often used in rural areas where the freeway is near natural ground and the cross road is carried over the freeway. This type has the advantage of eliminating the left turning movement of vehicles on the cross road approaching the intersections from the freeway side where sight distance may be restricted. Less right of way is required by this design than by a spread diamond; however, construction costs are usually higher.

When considered in conjunction with adjoining interchanges, this design may provide better weaving distances than would a four-quadrant diamond type. A pattern with loops for the on-ramps is considered preferable to one with loops for the off-ramps since better off-ramp alignment is provided and no left turning movements need be stored on the cross road on the freeway side of the intersections where sight distances may be restrictive.

PLATE 4



No Weaves Allowed

A further elaboration of the two-quadrant cloverleaf is shown in Figure 6 where free right turns are provided from the cross road. No weaves are involved in this pattern and the only left turns involved are from the off-ramps. When these left turns can be tolerated this design may be preferable to the full four-quadrant cloverleaf shown in Figure 7 since it is less expensive, requires less right of way and has no weaving conflicts.

Quite often when conditions are such as to justify a four-quadrant cloverleaf interchange the ramp traffic is so large that weaves on the freeway are considered objectionable, and collector roads are provided. The ramp noses on the freeway will therefore be located as much as 1000 feet or more from the cross road, and weaving distances between adjoining interchanges may not be adequate.

The two-quadrant cloverleaf with free right turns or the four-quadrant cloverleaf designs may be justified in built-up areas only when traffic volumes are expected to be extremely high, since right of way will be very expensive. In rural areas these types may be provided when the cross road is a major high speed facility.

Further Modification

The interchange type shown in Figures 8 and 9 is further modification of a four-quadrant cloverleaf to accommodate high predicted traffic volumes.

The design with one direct connection shown in Figure 8 might be justified to serve a predicted high peak hour volume from a nearby industrial plant. One of the major advantages resulting from this direct connection would be that the major traffic movement is not involved in any weaving conflict.

Figure 9 shows a design which braids out the weaving conflict between loop ramps. In some cases, this braided plan can be provided at a cost comparable to the four-quadrant cloverleaf with collector roads.

Another interchange type commonly used is the trumpet. This design may be shaped in many ways, one of which is shown in Figure 10. The trumpet may be appropriate when a cross road ends at the freeway or where a direct connection to built-up area is considered justified. In some cases the backward movements shown may not be required.

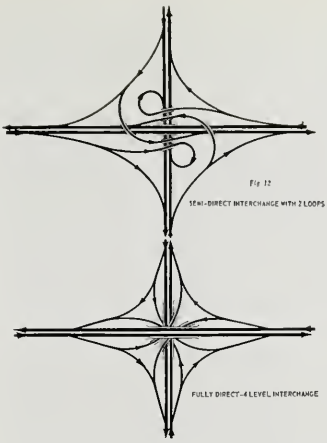
The design shown in Figure 10 has the disadvantage of ending what may be a high speed road on a loop connection. If conditions allow, this may be overcome by reversing the direction of the trumpet and placing the heavier volume on a loop ramp off the freeway where the lower speeds will be anticipated. A further disadvantage to the trumpet is the lack of adaptability if in the future it is deemed necessary to extend the cross road to the opposite side of the freeway.

Braid Method Costly

In the effort to provide satisfactory traffic service, we are often faced with the necessity of interchanging with two cross roads within one-half mile. If sufficient weaving distance cannot be provided between on- and off-ramps, these ramps must be separated by a braid as shown in Figure 11. Since it is obviously expensive to provide braids in this fashion, the designer will always investigate the many possible interchange types and shapes that might be provided to determine if any feasible alternates are available.

Interchange movements must also be provided when two through freeways intersect or where one freeway ends at the intersection with another. The minimum requisite of a freeway to freeway interchange design is that all movements must be free flowing, with no left turns. Several of the local interchanges previously discussed have this qualification. Among these are the four-quadrant cloverleaf and its variout possible modifications (Figures 7, 8 and 9). Other types are the semi-direct with loops shown in Figure 12, and the fully direct four level interchange shown in Figure 13.

The choice of the proper freeway to freeway interchange is often a difficult one. Differences in construction and right of way costs, circuity of travel, aesthetics, capacity, etc. are



significant and considerable engineering judgment is required in weighing these factors one against the other. In metropolitan areas, these interchanges are often further complicated by the necessity to provide local service within the interchange area. Experience has shown that each case is an individual one; an interchange pattern cannot be prototyped.

The four level direct interchange may be appropriate in a large metropolitan area where all movements are anticipated to be very heavily traveled. Interchanges of lesser cost and magnitude are provided with consideration to area, improvements, traffic service, cost, etc.

The diamond interchange is still the workhorse on the team of interchanges. Far from being a substandard facility, it can handle, if properly designed and signalized, very large volumes of traffic.

Delay on Loops

The delay to all cars going around a loop may be 30 seconds or more regardless of what other traffic may or may not be using the cross street. This 30 second delay is about three times the average delay at a traffic signal and more than three times the delay at a rural typical stop sign. In addition, if traffic volumes leaving a freeway at a given interchange are very large, this traffic will cause disrupting of the progressive movement along the city street regardless of whether it comes from a signalized diamond off-ramp or from a loop off-ramp. Conversely, if the volume coming from a loop off-ramp is small enough to be absorbed by the cross street without adding traffic lanes to the cross street, this volume can also be added to the cross street traffic stream by means of a signalized intersection.

At present there are more than 1,000 completed traffic interchanges in operation on the State Freeway System. Apparently State and city or county systems have met in about 1,000 instances. In observing the operation of these interchanges, it appears in general that mutual considerations have been successfully met. More important, it appears that we have profited from experience and the field of knowledge is increasing.

Bids Called for South State Jobs

The State Division of Highways has called for bids on large scale freeway jobs in Los Angeles and Riverside Counties.

The *Los Angeles County* project consists of constructing nine bridges on the future route of the San Diego Freeway between Studebaker Road and Cherry Avenue in and near Long Beach.

A total of $3,700,000 in state highway funds is available for the project.

Bridges will be constructed to carry the future freeway over Studebaker Road, Los Cerritos Channel, Stearns Street, Palo Verde Avenue, Woodruff Avenue, and Bellflower Boulevard.

The *Riverside County* project involves grading and paving to construct 5.6 miles of four-lane freeway on U.S. Highway 60 between Sunnyslope and Orange Street in Riverside.

A total of $5,530,000 in state highway funds is available for the project.

Eleven bridges are included in the project, including structures over the Union Pacific Railroad and the Santa Ana River.

This project will connect with three miles of freeway now under construction on U.S. 60 in Riverside.

Farmlands

Freeway Construction Requires Few Adjustments, Study Shows

A REPORT OF THE LAND ECONOMIC STUDIES SECTION, RIGHT-OF-WAY DEPARTMENT

Summation by BAMFORD FRANKLAND, Headquarters Right-of-Way Agent



A 13.6-MILE segment of Interstate Highway Route 5W in western Yolo County, California, was completed in January, 1960. This new highway, a freeway, was built on new location through an area which is entirely agricultural. The freeway right of way is a minimum of 208 feet wide and required the acquisition of some 438 acres of farmland. Forty-six farms now lie adjacent to the new route. Five of these were severed by the freeway, leaving a remainder on each side; strips of various widths were trimmed from one side of 38 of the farms; and only three of the total were not physically touched by the new route.

Purpose of Study

What are the consequences of freeway construction in such an agricultural area? What are the effects of the acquisition of a 208 foot right of way; of the acquistion of 438 farmable acres; of the severance of a farm; of the acquisition of a strip from the side of a farm; of the physical imposition of a freeway upon an area where none existed before?

The purpose of this study is to investigate these consequences of right of way acquisition and freeway construction, and to provide factual data which may assist in the evaluation of such factors in similar agricultural areas where future freeway may be considered.

Study Area and Freeway

Relatively few miles of freeway are constructed on new alignment through entirely agricultural areas. One such is in western Yolo County



The study area and freeway discussed in this article are shown an the above map by the heavy black line.

between the farm communities of Winters and Madison, in a portion of California's rich Central Valley. It is approximately 68 miles north and east of San Francisco, and 32 miles west of Sacramento. Its main marketing centers are Sacramento and the City of Woodland, which is 12 miles east of the study area. Map One illustrates this orientation.

The farm properties studied lie adjacent to Interstate Highway Route 5W, the western connecting link between Interstate Route 80 (serving the San Francisco Bay Area and points East) and Interstate 5 (U.S. 99W), which serves Northern California. Interstate Route 5W has been constructed entirely on new alignment, about a mile east of old State Highway Route 90, locally known at the Vacaville-Dunnigan Cutoff.

Sufficient right of way to construct an ultimate six-lane, full freeway was acquired. Initially, only two of the ultimate six lanes and two of the eventually needed eight grade separation structures noted below have been constructed. Eleven roads intersect the freeway at approximate one-mile intervals along the 13-mile route. Five of the 11 will interchange traffic with the freeway. Three of the intersecting roads will cross the freeway but will not provide access to it, and while the remaining three roads will neither interchange with nor cross the freeway, they connect to roads which do. Access to and/or across the freeway is now at approximate two-mile intervals.

Character of Area

The Winters-Madison area has been in a state of transition for over 20 years. An adequate water supply, a nearly level farming surface, and improvements in farm equipment have encouraged farm operators to gradually change from dry farming to irrigated row crop farming.

Prior to 1938, the approximate 8,750 acres contained in the ownerships abutting the freeway route were nearly all farmed by their owners to field crops which do not require land leveling. By 1961 over 5,000 acres had been leveled for irrigated row crop cultivation. Almost 3,400 acres are still farmed to field crops but this acreage is decreasing each year. About 350 acres of the choicest soils in the area traditionally have been devoted to fruit and nut orchards.

The basic dry field crops are barley and wheat. Basic row crops are tomatoes, sugar beets and alfalfa, while the orchards produce walnuts, almonds, peaches, apricots and prunes.

Along with the trend toward conversion of land to more intensive farming uses has gone a trend toward absentee ownership. Only 23 percent of the 8,750 acres are still owner-operated.

Study Method

One practical approach to the determination of the consequences of free-

way construction in an agricultural area is to catalogue and analyze both the *changes* which have occurred in adjacent properties and the *adjustments* made by their owners or operators subsequent to the acquisition of right of way. Either the changes themselves, or the lack of changes and adjustments, would be indicative of and could lead to a conclusion of freeway effects. This is the approach used in this instance, and it necessarily presumes that farm operators will attempt to adjust quickly to the new conditions imposed by a freeway in order to continue to operate their farmsteads profitably.

Five major alternatives are available to the farmer in adjusting to any freeway-induced changes in his operations. He can:

1. As an owner, sell or lease all or portions of his land, or buy or lease additional units.
2. As a tenant, cease operating; sublease all or a portion of his leasehold; or change his lease terms as soon as possible.
3. Change his farming practices and/or the crops raised.
4. Change the farm improvements.
5. Make changes in his equipment inventory.

Each farm in the study area was carefully analyzed in the light of the above alternatives. Additionally, an attempt was made to establish what portion of the monies paid for rights of way had been reinvested in the various farms. It was felt the reinvestment of such payments in the farms involved would clearly provide another helpful insight into freeway effect.

In carrying out the above approach, the five major change factors were investigated over a four year period starting in April, 1957, the date of the first right of way acquisition in the area, and January, 1960, one year—or one full crop cycle—after completion of freeway construction. Within this framework separate analyses were made of the three basic farm types, i.e., *orchards, row crops,* and *field crops,* to evaluate differing effects, if any, attributable to the freeway.

Additionally, within these three subcategories, farms which were *trimmed*, those which were *severed*, and those which were *not touched* by acquisition, were also separately examined. (A trimmed farm may be defined as one where right of way was acquired along its boundary leaving the remainder as one entity; a severed farm is one in which right of way acquisition has left a remainder on each side of the freeway.)



This aerial view showing the freeway under construction illustrates the intensive cultivation practiced in the area.

Map Two shows the 46 property ownerships in the study area as they existed in 1957 prior to right of way acquisition for Interstate Route 5W. Also, represented on the map are internal field divisions and the locations of farm residences. Map 2-A shows the same properties and their relationship to the new freeway.

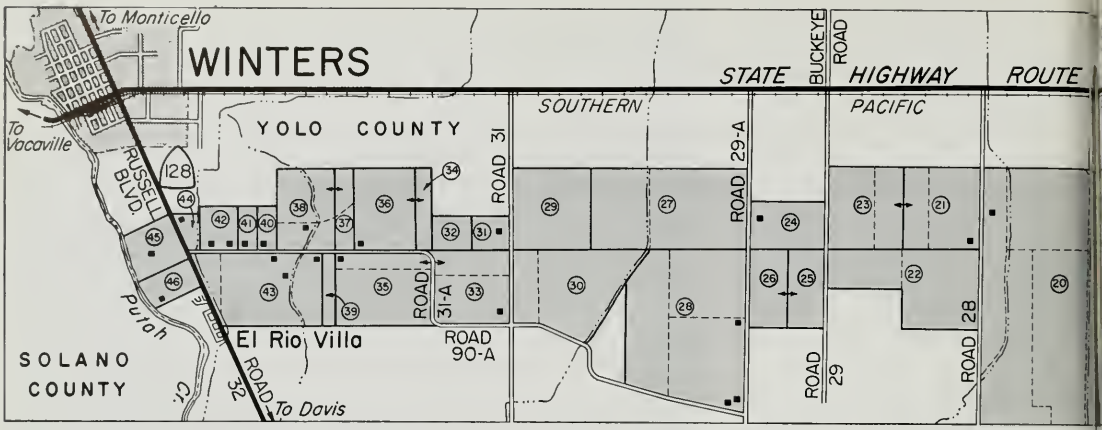
Ownerships

A tabulation of farm ownerships in the study area revealed a wide range of farm sizes as well as a wide range of amounts of farmland acquired for rights of way. The smallest operating farm (an orchard) in the area contained slightly over ten acres as opposed to the two largest individual holdings of approximately 1,200 acres each.

Right of way was acquired in amounts ranging between 0.04 acre and 38.64 acres from 43 of the 46 adjacent ownerships. Only three parcels were not touched in some way by the freeway construction. Five ownerships were severed and the remaining 38 were trimmed by widely varying amounts.

There are several courses of possible adjustment which an owner might take as a result of the reduction in size or severance of his property. For one, he can change, in some manner, the size of his farming operation. He might add to his holding—as replacement for the land required for right of way—or he might dispose of all or portions of his ownership to eliminate difficult farming operations. Either of these alternatives could be accomplished by means of purchase, sale or lease.

Four of the subject properties have been sold during the four year study period—at prices which are equivalent to or in excess of the going acreage rate in the area. Three of the sales were normal transactions which would have occurred in the absence of a freeway. One—an 80 acre parcel from which



This map shows the outlines of study area properties, improvement locations and field div

0.08 acre had been acquired for the purpose of improving the junction of two county roads—sold when its owner retired. Another—a part-time farm—sold following the death of its owner. The third was another 80 acre farm from which slightly over two acres were acquired. This farm has actually sold twice during the study period and is now again listed for sale. Each sale has been to a speculative purchaser who did not himself intend to farm the property, and each sale and the listing have reflected an increase in value over the base price in the area.

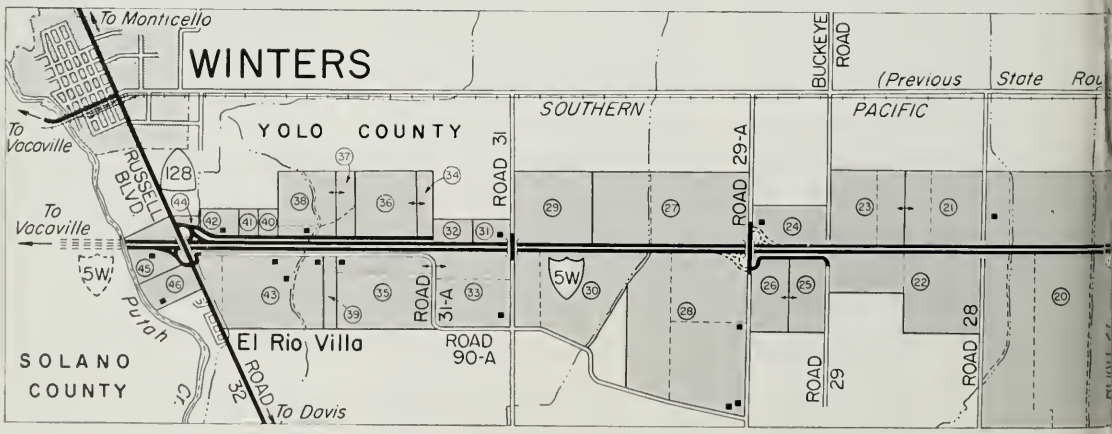
The fourth sale was of the smallest parcel affected by the freeway. An interchange ramp system required the acquisition of nearly nine of its ten and one-half acres. After its sale (for a price 50 percent in excess of its agricultural value) a service station and soft drink stand were constructed on the small remainder.

No other actions affecting farm sizes have been taken by owners in the study area. *None have sold a portion of their farms; none have leased all or any portion of their farms* (except in one instance where an owner died and his heirs leased the property rather than sell it) *and none have purchased or leased any replacement land.*

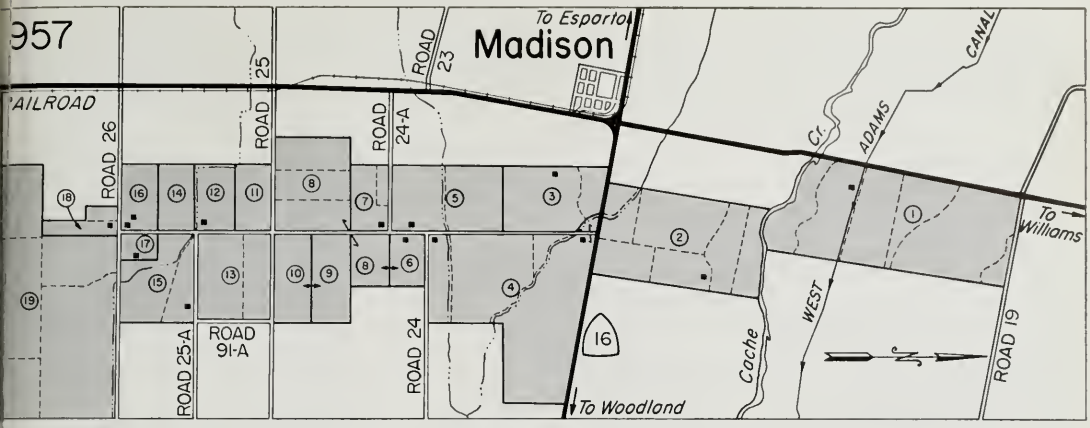
Leases and Lease Terms

The study of ownership changes reveals attitudes of owners toward the newly constructed freeway. Only 20 of the 46 properties were, however, owner operated. The remaining 26 properties are operated by lessees (tenants).

Three basic adjustments by tenants to adverse forces are possible: An operator might give up his lease entirely; he might revise his leased unit arrangement by sub-leasing all or portions of the leasehold or; he might



This map shows the location and ultimate construction of Interstate Route 5W near the towns of Winters and Me



e freeway construction. The arrows connect separate properties which are farmed together.

seek relief through a change in the terms of his lease.

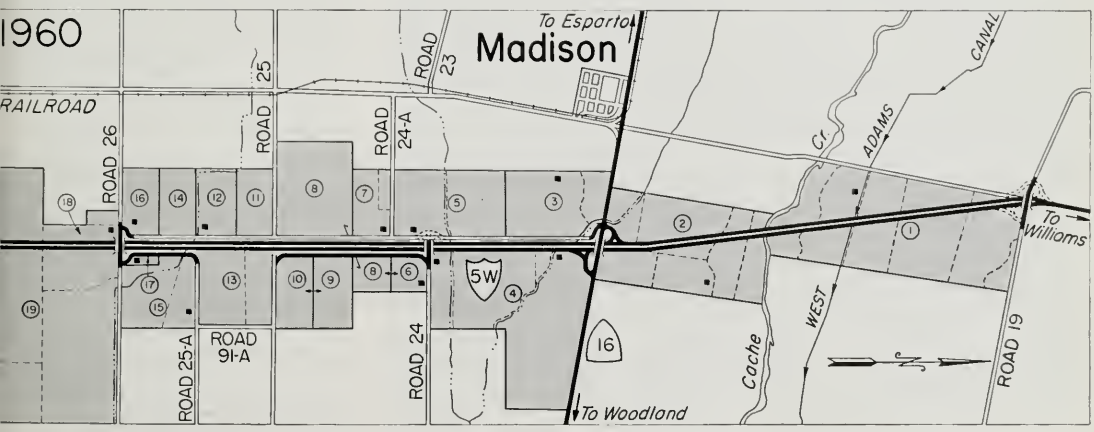
The first mentioned reaction (giving up the lease) is highly unlikely since it would probably affect the capability of the tenant to lease other land in the area. No operators have taken this course of action. Only one tenant has resorted to the second alternative. In this case the operator sub-leased two small ownerships containing about 54 acres to another nearby operator, after the parcels had been severed from the larger portion of the operating unit.

With respect to lease terms, it is apparent in this area that the growing trend toward tenant operation of farm units has strongly increased the competition among tenants for available land. For this reason it would seem more probable that any increase in difficulty of farming might be first compensated for by a change in lease terms if possible, and only secondly by a change of operator.

Ten of the 26 leases in the area have come up for renewal during the study period. Three of these covered farms which had been severed by the freeway route and seven were leased farms which had been trimmed. *All ten leases were renewed by the same operators and no changes were made in lease terms.*

Crop Changes

Perhaps the simplest adjustments an owner or operator might make are in his farming practices or crops raised. Two alternatives were considered. The one major alternative available is for the farmer to compensate for increased farming difficulties by planting crops which require less care. This adjustment was not made by any of the farmers in the study area. *There have been crop changes but in each of the six cases noted, the changes have been to crops requiring more rather than*



erchange structures have been completed only at the freeway intersections with State Sign Routes 128 and 16.

less care. The changes, moreover, were all made in accord with the trend toward more intensive cultural practices previously noted and as part of long range land conversion plans. *In each case land previously devoted to field or row crops was upgraded for row crop or orchard use.*

The minor alternative considered was that a farmer might combine some of his fields to enable reduction of the number of separate cropping operatings performed. The 46 ownerships in the study area had been divided into 85 fields by their owners or operators. These divisions (before and after freeway construction) are noted on Maps 2 and 2-A.

Freeway construction induced only one instance of field realignment; a unit made up of three 80 acre fields has been combined into one 240 acre field. The combination did not involve any change in the basic crops planted but was accomplished by an alteration in the crop rotation cycle in two of the fields to bring all three into the same rotational phase.

Farm Improvements

Changes in farm equipment inventories and adjustments in or additions to farm improvements are other elements which might be expected to reveal the effects of freeway construction. Has it been necessary for owners or operators to buy additional equipment as a result of freeway construction or; has the location of the freeway or the amount of land required for right of way caused some existing equipment to become obsolete? Has it been necessary for owners or operators to construct additional improvements as a result of the freeway location or; has it been necessary to change the use of existing improvements to meet new conditions?

First, in the area of equipment inventories: *none of the owners or operators of trimmed units have purchased any additional equipment since the date of first right of way acquisition and all have continued to use their existing equipment in the same manner as before. Only two operators of severed units have made any new equipment purchases.* Each has purchased a trailer for the purpose of carrying tracked equipment over the freeway to a severed unit. These represent an investment of approximately $2,000 each. None of the owners or operators of other severed units have bought any new equipment. All continue to use existing equipment as in the case of owners of trimmed units.

Farm improvement were found on only 28 of the 46 farms in the study area. These were generally limited to residences and outbuildings erected during the period when the owner-operation of individual farm units was predominant. Only 19 owners were still in residence on their farms, some as part-time farmers with other places of employment and others as owners who had leased their farms but still lived on the farmstead. There were extensive facilities for prolonged crop storage on only one of the subject farms.

Replacement of improvements which fell within the right of way area was negligible. Five owner-occupied and six tenant-occupied residences, seven barns, four sheds and four garages lay in the path of the freeway. These were purchased by the state at a cost of $123,000. Following this acquisition, two of the tenant-occupied homes and a barn were moved to remaining property, and two new homes were constructed on other remainders. Approximately $30,000 has been expended by the three owners for the above noted moving or replacement costs and the remaining owners who did not make replacement indicated in interviews that the monies paid for improvements had been placed in savings. *There have been no additional improvements constructed on any of the farms; no changes in use of existing improvements; and no adjustments made as a result of freeway construction.*

Compensation

A total of nearly $625,000 was paid to the 43 affected owners from whom rights of way were acquired. This total included $316,000 for land; $123,000 in payments for improvements; and $186,000 as compensation either for curative work to be done by the owner, or for appraised reductions in value of remaining properties. The individual payments ranged from a low of $45 to a high of $97,500.

No owners were found who had invested their land payments in substitute lands. Interviews with the recipients and field estimates established that of the $309,000 paid for improvements and damages only 24 percent was reinvested in the subject properties. Overall, about 88 percent of the total $625,000 was actually placed in savings.

1. Investigation and analysis in this instance has indicated that owners and operators have found it necessary to make only minimal changes and adjustments as a result of right of way acquisition and freeway construction in the agricultural area studied.
2. It was early premised that the degree of impact of acquisition and construction would be reflected in the frequency and extent of changes to the original farmstead, following the reasoning that operators would attempt to quickly adjust to any new conditions imposed by the freeway if production and efficiency were significantly impaired. Since such action has been negligible, it follows that the impact of the new freeway in this instance has been negligible as well.
3. In the areas of farm ownership and lease operator–lease term change, the impact has been particularly slight. The buying and selling of farms, and the exchanging or sell-of portions of farms to minimize operational difficulties (actions logically premised if freeway construction were significantly disruptive) are not at all in evidence in the study area. Neither do the lease changes which have occurred appear to indicate other than minimum effect.
4. The analysis of the disposition of monies paid to farmers; of the additional equipment purchased; and the replacement of improvements has also failed to reveal evidence of particularly significant freeway-induced adjustments.
5. It is further apparent that freeway construction has not necessitated any change in the basic crop pattern of the area, nor has it interrupted the normal trend toward more intensive farming practices.

New 17-Mile Road

Los Banos-Turlock F.A.S. Project Opened

By RAY J. GEIMER, Assistant City and County Projects Engineer, District X

DELINEATED on California Highway Planning Maps since the advent of the Federal-Aid Secondary Road Program following World War II was a dashed line indicating an unconstructed road as a portion of FAS Route 914 running due north from the City of Los Banos in Merced County.

Perusing a road map, it is quite apparent that construction of this segment of FAS Route 914, will afford a large savings in distance and travel time to the highway user traveling between the Cities of Los Banos and Turlock.

However, when one views the area on the ground, it can be readily understood why this portion of the route remained unconstructed for so many years. The project bisects a large area of central Merced County comprising approximately two hundred square miles which has remained in its natural state. The virgin land is devoted generally to grazing for livestock and numerous duck clubs in the flooded lowlands.

During heavy winter rains and the spring runoffs, flooding occurred over large areas adjacent to the San Joaquin River. In order to attain an all-year usable facility, it was necessary to invest a large sum of money to obtain a road built to adequate standards.

Benefits Recognized

Actively promoting the proposed project were the late Wm. A. McCanless, former Road Commissioner, and Supervisors Harry P. Schmidt and Emory O'Banion. Recognizing the desirability and obvious benefits of the project, the Board of Supervisors of Merced County, in 1956, indicated their intention of budgeting all available FAS and State Matching allocations, as they became available, to complete the construction for the full length, 17.4 miles, between Los Banos and State Highway Route 122.

In cooperation with the State Reclamation Board and the State Depart-



The above map shows the location of the new 17-mile highway.



This bridge across the San Joaquin River is on the new Los Banos-Turlock Road constructed under the F.A.S. program in Merced County.



A northward view of the new Las Banas-Turlack Road showing the Santa Fe Canal crossing in the foreground.

ment of Water Resources, the bridges across the San Joaquin River were designed to accommodate the plan of the Lower San Joaquin Flood Control Project.

During 1959, the northerly nine miles were completed with the exception of the surfacing. Included in this contract were three reinforced concrete bridges totaling 565 feet in length and ten reinforced concrete box culverts.

South Portion Completed

During 1960, the southerly eight miles were completed with the exception of the surfacing. The contractor on both of the above contracts was M. J. Ruddy & Son.

Recently completed was a contract for the surfacing of the complete 17 miles of road. The contractor was Baldwin Contracting Company.

The estimated total final cost of all three contracts, including construction engineering, will be approximately $1,346,000, financed with FAS funds in the amount of $765,000; State funds in the amount of $464,000; and County funds in the amount of $117,000.

Completion of this direct connection between the City of Los Banos and the City of Turlock will save highway users, over a period of twenty years, an estimated 44 million vehicle miles, having a value of $4,000,000. In addition, this high-type road will contribute toward the development of a higher land use through the area traversed.

Engineering of the projects is a good example of the fine cooperation existing between the State Division of Highways, the U.S. Bureau of Public Roads, and the Merced County Road Department under the Federal-Aid Secondary Road Program in California.

Preliminary engineering was done almost entirely by personnel of the County Road Department. The projects were advertised and administered as State highway contracts.

Construction engineering was performed by both State and County personnel. Resident Engineer for the first contract was C. F. Roderick. G. T. Guy was Resident Engineer for the second and third contracts.

New Traffic Record On Dumbarton Bridge

The average daily traffic across the Dumbarton Bridge reached an all-time high during March of 7,007 vehicles. This is a 21 percent rise above the March, 1960, average daily traffic of 5,790 vehicles. The San Mateo-Hayward Bridge also broke a previous record. A new high point for a single day's traffic was established on Easter Sunday, April 2, 1961, with a total of 14,715 vehicles. The previous high record was made on Easter Sunday, April 17, with a total of 14,592 vehicles.

Archaeology

State Agencies Cooperate to Save Valuable Midden Sites

THE STORY of past ages of man in California is being uncovered and the relics of ancient cultures are being preserved as a byproduct of the state's big highway program.

This is being accomplished through the cooperation of Federal and State agencies carrying out what the Bureau of Public Roads defines as a national policy to preserve or salvage ruins, sites, artifacts, fossils or other objects of antiquity.

Financing from Federal funds was authorized by the Federal-aid Highway and Revenue Act of 1956 which provides that funds may be authorized to the extent approved as necessary by the highway department of any state for archaeological and paleontological salvage. In some cases, only State funds are involved.

Recognizing the value of this salvage, the Division of Highways was quick to cooperate, as was the Division of Beaches and Parks. A four-phase program for the actual preservation and salvage work was instituted, outlined in a letter from the State Highway Engineer to the various Districts in March, 1957. These four phases are:

1. Coordination, which means, chiefly, keeping Beaches and Parks informed of the road program so that a determination can be made as to the existence of any archaeological sites or objects which will be disturbed by highway construction.
2. Surveys by archaeologists to determine exact location of orchaeological sites in the path of highway construction.
3. The actual excavation and salvage of worthwhile historical objects.
4. The packing and removal of the salvaged objects from the site.

The Division of Highways' participation was limited to Phases 1 and 3. The Districts provide all available data to the Division of Beaches and Parks, and, after a survey by Beaches and Parks to provide an estimate of cost, an interagency agreement is executed providing for Highways to furnish the necessary funds for the actual excavation and salvage of worthwhile objects.

Since archaeological salvage is a very specialized procedure requiring special skills and techniques, Beaches and Parks which does not have the manpower availoble, arranged for other agencies, such as the University of California Archaeology Survey and the Central California Archaealagical Foundation to supply the necessary skilled workers from among their advanced students.

Three projects have been very satisfactorily handled in this manner: One in Santa Barbara County near Goleta, one in San Diego County near Carlsbad, and one in Sacramento County near Folsom.

The accompanying account describes the San Diego County project:

By CLAUDE N. WARREN, ELIZABETH VON TILL WARREN, and ERNEST CHANDONET, University of California, Los Angeles

The large scale highway construction being undertaken in California is creating a problem for archaeologists working in the state, for the resultant destruction of archaeological sites is a growing concern. Along existing roads, it is not uncommon to see dark patches of midden, marking the camping places and villages of prehistoric inhabitants of that area. The new freeways, of larger size and designed so that a greater amount of earth movement is necessary in their construction, will undoubtedly cross many more archaeological sites than did the roads constructed in the past. This destruction of sites, however, does not mean the loss of the scientific data they contain, because of the cooperative program developed by government agencies.

The first step toward an active program of highway salvage archaeology in southern California was initiated in June 1959. This initial step, an archaeological survey of the right-of-way for the proposed new U.S. Highway 101, between Carlsbad and the northern city limits of San Diego, resulted in a contract between the University of California Archaeological Survey, Los Angeles, and the State Division of Beaches and Parks for the salvage of the archaeological remains of two sites on Batiquitos Lagoon. A second survey of the U.S. 101 right-of-way in Santa Barbara County in the summer of 1959 resulted in a contract for the immediate salvage of the archaeological remains of two sites near Goleta.

Salvage excavations in San Diego County were begun in August and September 1960, under the direction of Claude N. Warren and Robert H. Crabtree. The operations have not yet been completed and further work is planned for the near future. This report is presented to illustrate how important remains of the prehistoric peoples of southern California are being recovered.

Method Described

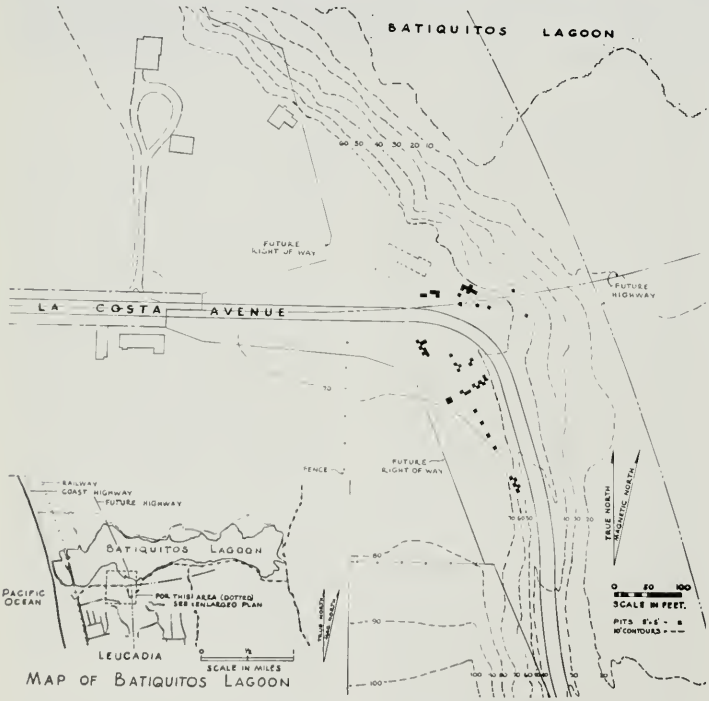
In surveying rights-of-way for archaeological remains, the archaeologists, who usually work in pairs, walk the length of the right-of-way in search of areas where there are indications of prehistoric habitation. Such sites are recognizable by the presence of midden, a dark colored soil resulting from the high organic content of decomposed food remains and refuse. In coastal areas in California, such archaeological sites often contain large quantities of shells discarded by the prehistoric peoples after eating shellfish. Also common throughout the state are areas where stone tools and broken rock are found on the surface of the sites as indicators of previous habitation.

Once the site has been located, the archaeologist collects from the surface

JUL 14 1961



Looking south across Batiquitos Lagoon toward Leucadia. The archaeological sites are located near the oblong reservoir in the raised rectangular area (center foreground) and in the vicinity of the looped driveway and rectangle of trees (middleground).



MAP OF BATIQUITOS LAGOON

A map of the excavation area near Batiquitos Lagoon. The individual excavation areas are indicated by the solid black squares and rectangles.

all the artifacts (tools and implements) left by the former inhabitants and notes any features such as remains of hearths or structures. Study of these remains often is sufficient to indicate whether or not excavation of the site would yield enough information to make a salvage contract worthwhile. If, after studying the surface collection, the archaeologist is still uncertain about the importance of the site, test excavations are undertaken. Test excavations are generally limited to a small number of pits, 5 feet square, which vary in depth with that of the deposit. Such excavations tell the archaeologists how deep the deposit is, give him a rough estimate of how many artifacts are to be found per cubic yard, and how difficult the actual digging may be.

On the basis of the information collected in these surveys and test excavations, a contract proposal is submitted to the Division of Beaches and Parks, which functions as the coordinating agency between the Division of Highways and the archaeological agency. The expenses for salvage excavations are paid out of highway funds, and by the archaeological agency undertaking the excavation. Generally, the expenses for labor and replacement of equipment are paid by highway funds, while the archaeological agency supplies all equipment, transportation, and publication costs.

Cultural Affiliation of Sites

During the archaeological reconnaissance of the highway right-of-way between Carlsbad and San Diego, two sites worthy of salvage excavation were discovered on the right-of-way. These sites, designated SDi-211 and SDi-603, are located on the margins of Batiquitos Lagoon near Leucadia, California.

SDi-211 is a large site extending one-quarter of a mile along the cliff on the north side of the lagoon. An area approximately 250 feet by 100 feet on the east end of the site will be destroyed by the road cut proposed for the new freeway. The midden in this portion of the site is poorly developed, light brown in color and contains relatively few shells. Artifacts, however, were observed in relatively large numbers on the sur-

face and limited excavations yielded slightly over 200, as well as several features, consisting of broken rocks and artifacts placed together in small piles or cairns.

Second Midden

Site SDi-603, located on the south side of Batiquitos Lagoon is less extensive in area than SDi-211, but has a more developed midden containing large quantities of shell, rock, and organic materials. An existing street, La Costa Avenue had already cut through a portion of the site, exposing midden deposit of 3½ to 4 feet deep. A burial exposed by erosion in the cut was recovered by the San Diego Museum of Man prior to the start of salvage operations. Two carbon samples, one below and one above the burial, giving dates of 7300 ± 200 and 3900 ± 200 years ago, respectively, were assayed by Scripps Institution of Oceanography, La Jolla. Rather extensive excavations undertaken at site SDi-603 during the salvage work, have yielded about 400 artifacts and 14 features similar to those at SDi-211. Unfortunately, no more burials were recovered. More excavations are planned for this site, and it is hoped that burials as well as more of the cultural material of the early inhabitants will be found.

On the basis of the artifacts recovered from thes sites, the rock features and the carbon-14 dates, site SDi-211 and the lower levels of site SDi-603 are judged to belong to an ancient culture termed "La Jolla" because it was first discovered near La Jolla, California. The upper levels at SDi-603 contained potsherds (fragments of broken pots) which indicated that people of a later culture, called "San Luis Rey" by the archaeologists, occupied the site after the time of the La Jolla people.

The people of the La Jolla culture made their living by gathering seeds and roots from the nearby mesas and shellfish from the deep cut bays that characterized the San Diego coast line some 4000 to 7000 years ago. Batiquitos Lagoon, now a salt marsh no longer capable of supporting shellfish, was then a typical example of such a bay. At a time during the last glaciation, the sea level was considerably lower than at present, since great



A shell midden exposed by a road cut. The dark soil and shellfish remains of such middens are indications of former human occupation of the area.



Excavating Site SDi-603. The five-foot-square pits used as excavation units are visible to the left of the dirt piles.

quantities of water were then locked in the huge glaciers of the northern hemisphere. During this period of lowered sea level, the streams and rivers flowing westward to the ocean in San Diego County cut deep canyons in the relatively soft deposits of the coastal plain. Some of these canyons were as much as 100 feet deeper than they are at present.

Valleys Are Flooded

With the melting of the glacier, the water returned to the ocean and the sea level rose, flooding the deep coastal valleys and creating deep, narrow bays. These bays supported large



Stone features at Site SDi-211. The round pile of rocks is probably an ancient hearth, while the smaller, irregular scattering to the right may represent waste material left by an aborigine after making tools.

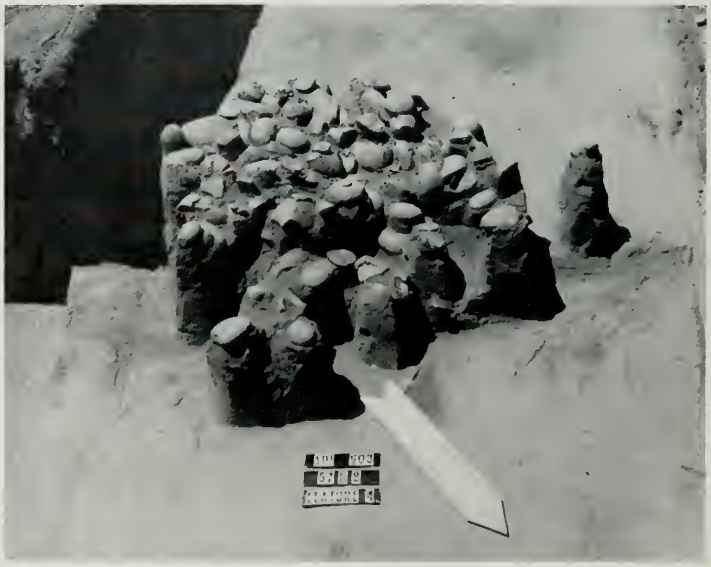
quantities of shellfish and it is thought that it was during this time that the La Jolla people came to the coast. Where they came from we do not know, but they appear not to have been adapted to a maritime way of life, since they did not take full advantage of the supply of food offered by the ocean and bays. For example, no specialized fishing gear such as the shellfish hooks of later, sea-oriented people, or harpoons for the hunting of sea mammals, have been discovered in La Jolla sites. The tools found, illustrated in the accompanying photographs are the exceedingly crude implements used for scraping, pounding and grinding. Most common are the mano and metates used for grinding of seeds. Rarely, a dart of spear point is found, and correspondingly scarce are the bones of mammals hunted with such weapons. Fish bones occur, but not in the quantity that might be expected in the remains of a people living near the sea. The only sea food remains that occur in quantity are the shellfish from the shallow waters along the shore.

These archaeological remains suggest that the economy of these people was adapted to the collecting of wild plants, with occasional hunting of small land mammals. This economic pattern is more characteristic of an inland group than of a people living beside the ocean. It is thought, therefore, that the La Jolla people migrated to the coast from the desert region. This theory is further supported by the fact that the deserts were becoming increasingly dry as the glaciers melted. The great desert lakes evaporated, and the region could no longer support the population of plants and animals (man included) that it formerly had. This dessication of the desert, as far as we know, took place at about the same time that the La Jolla people first appeared on the coast.

Lacked Techniques

Upon reaching the shore of the ocean, the La Jolla people, with their gathering economy, did not have the techniques or the technology for hunting sea mammals or taking fish in great quantities. On the other hand, the gathering of the shellfish which occurred in quantity in the bays created by the rise in sea level, could easily fit their former way of life and provide them with a food supply capable of supporting a relatively large population. A large population is suggested by the large number of sites found along the edges of the lagoons of the San Diego coast.

The history of the La Jolla people is recorded in the midden at site SDi-603 on Batiquitos Lagoon. Salvage excavation at this site included not only the recovery of the crude stone artifacts and the recording of the peculiar stone features, but also the taking of samples of the midden in order to discover what the main food resources were and any changes



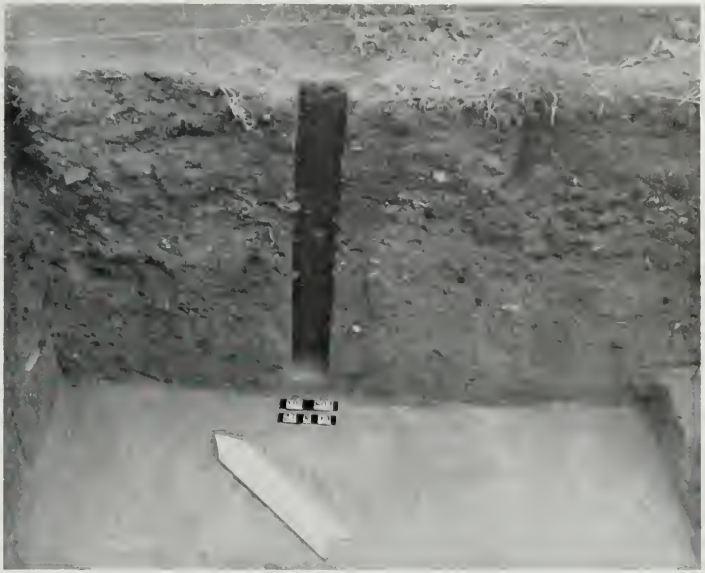
Stone feature at SDi-603, probably a hearth.

in the economy that might have taken place. This kind of ecological study includes detailed analysis of the stratigraphy of the site as well as actual sampling of the midden. Sampling of the midden is done in a number of ways, none of which are error proof, but which are used in cross checking one another to achieve the most reliable results obtainable. Seldom is it possible to study an entire midden and never is it possible to do so when the archaeologist is racing against time and the bulldozer in a salvage operation.

Three methods of sampling were used at SDi-603. The first type, termed, "column sampling", is truly a sample of the midden, including the dirt, rock and all material within a specific volume of the midden. This kind of sample necessarily is small because of the difficulty of transporting it from the field to the lab where it is analyzed, and because the analysis of it is so time consuming. The technique is so named because the sample consists of a *column* or core 4 inches square running through the depth of the midden. The column is taken in 6 inch segments in order to discover any changes that may occur in the midden composition from the bottom to the top. For example, the bottom 6 inches of the column may include different species of shellfish from the top 6 inches, and thus show a change in the food resources used. Twenty-seven column samples were taken from SDi-603 and are now being analyzed.

Micro-Analysis

Another kind of sampling, generally called "micro analysis", utilizes a larger quantity of midden than the column sample, but with less control. The unit of the micro analysis is a 5 foot square column running the depth of the midden, taken in 6 inch levels. Each of these levels is passed through a set of screen of ½, ¼ and ⅛ inch mesh. The residue is taken for analysis. The soil is discarded and therefore percentage of the midden components by weight cannot be ascertained. However, the sample of shell, bone and small artifacts such as beads is enlarged, and provides a check for the column sample on these items.



Profile of a five-foot-square pit with a column sample removed. Note how the soil changes from sterile sand at the bottom of the pit to a shell-bearing deposit in the middle and to a stratum containing few shells at the top.

Another type of sample taken at SDi-603 might be called the "whole-shell sample." In this type of sample, the levels were screened through a ¼ inch mesh in an attempt to get a sample of the whole shells present. Again the unit was the 5 foot square, dug in 6 inch levels. The whole shells of this sample are to be studied to determine whether or not, in addition to species changes that probably occurred in the shellfish with the silting in of the lagoon, there was also change within a species, such as a decrease in size or increase in mutations, possibly reflecting a change in the salinity and temperature of the water in the lagoon.

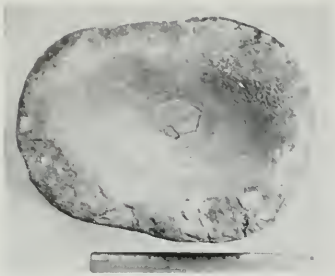


Only two projectile points were recovered from the excavations of Batiquitas Lagoon out of a total of approximately 600 artifacts. The large specimen (above) was from the La Jolla portion of the midden at SDi-603. The small one is from the surface and is typical of points found in San Luis Rey sites.

At the time of writing, the samples taken have yet to be analyzed completely, and only the field observations and a very small portion of the micro-analysis pits have been studied. The results as presented here are thus tentative and subject to change upon the completion of analysis of all midden samples. However, the information and interpretations are given here to illustrate how the archaeologist uses these data in reconstructing the culture history of the aboriginal population of the southern California coast.

Strata Are Thin

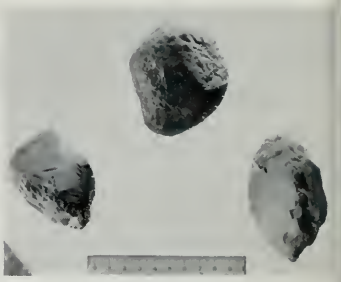
The stratigraphy of the site is only slight and the different strata grade into one another rather than from clear breaks. There appear to be four strata containing remains of human occupation. The deepest and there-



A typical La Jolla metate used with a manos to grind seeds.



A manos from Site SDi-603. Manos and metates are among the most common artifacts in the La Jolla sites, indicating rather extensive use of wild seeds as food.



Hammerstones used for flaking stone in the production of tools.

fore the oldest is 7 to 10 inches thick, a light brown sandy soil containing a few shells and split mammal bones in addition to artifacts. The second stratum is 7 to 9 inches thick, gray brown, compact and containing large quantities of shell and some ash. Nearly all stone features discovered in SDi-603 were located in this stratum. This appears to represent the time when the population was heaviest, since rock features, artifacts and food remains appear to be more common in this stratum than the others. The third level is 10 to 12 inches thick, compact light brown soil which contains only small quantities of shell and other food remains. It apparently represents a decrease in the population. The fourth and last stratum is 6 to 7 inches thick, and represents humus and plowed soil. The soil is loose, lumpy and full of rootlets. The food remains appear to be approximately the same as those of the third stratum.

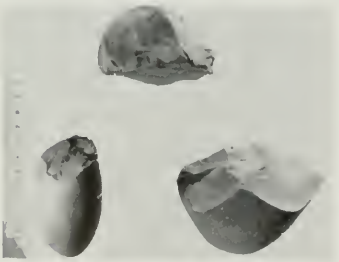
Potsherds, representing the San Luis Rey culture, are found in stratum 4 and the upper half of stratum 3.

In addition to the quantitative differences in food remains of the strata, there also appear to be qualitative differences. The earliest stratum seems to contain relatively more split mammal bone and more rock-dwelling shellfish such as mussels than the upper levels. Starting with the second level, there appears to be a shift toward the shellfish which live in mud or sand and fewer mammal remains are found. If this is true, two occurrences may be reflected in these remains: the lagoons were becoming silted in so that the rock-dwelling mussels were more scarce, and the La Jolla people were depending more heavily on the food reserves of the lagoon and not hunting land mammals as before. This is also the time when the population appears to be the heaviest.

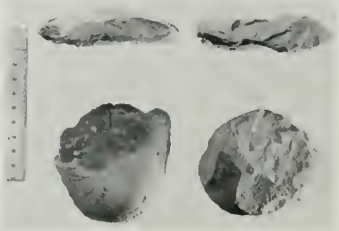
Silting of Lagoon

Stratum 3 probably represents the period when the silting in of the lagoon had reached a critical point and it could no longer support shellfish in any quantity. What happened to the people of the La Jolla culture when this happened remains one of the problems to be solved. However, the midden at SDi-603 suggests that the population diminished when the shellfish supply dwindled; the La Jolla people either moved elsewhere or the population dwindled too. It is through excavation sites such as SDi-603 and the study of their remains that what happened to these people may be found out.

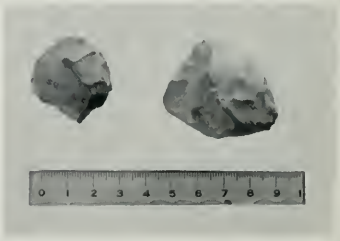
The San Luis Rey people came into the area late, and represent the Luiseno and probably Diegueno Indians of historic times. The San Luis Rey culture represents a migration of Shoshonean and Yuman speaking peoples into the coastal areas from the desert region to the east. SDi-603 is near the border between the Shoshonean speaking Luiseno and Yuman speaking Diegueno and may have been occupied by either or both groups. The very limited cultural inventory representing the San Luis Rey culture (potsherds and 1 projectile point, plus a few scraping tools) found at this site



Large scrapers and choppers common in La Jolla sites.



Small scraper-chopper combination tools from Site SDi-603. Some combination tools are common in La Jolla sites. The two to the left are profile views.



Small, well-made scrapers are almost always present in La Jolla sites.



Batiquitos Lagoan during the winter months. During the summer the lagoon becomes completely dry.

suggests that it was inhabited only seasonally and then for short periods of time.

Though much remains to be learned about the prehistory of the San Diego coast, the salvage operations at SDi-603 and SDi-211 have been and will continue to be a great help in the reconstruction of past cultures of the area. The cooperation of the Division of Highways, State Division of Beaches and Parks, and the University of California Archaeological Survey, Los Angeles, has made of the construction of present freeways a means for the reconstruction of past cultures. Modern highways thus enrich our lives with not only the benefits of modern engineering and technology, but also the knowledge of man and cultures of the ancient past.

Acknowledgments

The authors wish to thank Mr. J. Dekema, Mr. J. F. Jorgensen, Mr. J. M. Damberger, Mr. C. Wigginton and Mr. Ralph Davis of the Division of Highways office in San Diego for their assistance in this project; Mrs. Mary Barnes, the Reverend William Savage, Mr. Perry Lamb and Mr. and Mrs. Laddie Pottroff for permission to excavate on their property before it had been purchased by the State; Dr. Carl Hubbs, Mrs. Jackie Miller and the other members of the staff and faculty at Scripps Institution of Oceanography for their interest and aid in the excavations. We would also like to thank the Ed Fletcher Company of El Cajon, California for use of their building near the site as field headquarters, and to thank Mr. Jack Dyson and Mr. Francis Riddell of the State Division of Beaches and Parks, and Mr. W. L. Warren and Mr. Oliver Arnold of the State Division of Highways for their cooperation in obtaining and executing the contract for the salvage operations at the sites.

I.T.E. to Sponsor World Conference

The Institute of Traffic Engineers will sponsor a World Traffic Engineering Conference in Washington, D.C., from August 21 to 26. The conference will combine the 31st Annual Meeting of the Institute with the International Sessions in Traffic Engineering. The conference will be the first of its kind and will be attended by traffic engineers and highway officials from all over the world.

Discussion panels and lectures will be held on all phases of traffic engineering during the six-day conference.

Reports on design of interchanges and rural freeways will be made by representatives from Australia, Belgium, France, Germany, Japan, Mexico, the United Kingdom and the United States.

Panel participants from the California Division of Highways will include Karl Moskowitz, Assistant Traffic Engineer, and George A. Hill, District Engineer of District VII in Los Angeles.

A one-week tour by bus following the Conference is being planned for those interested in studying some of the traffic and design problems first hand.

Twenty Employees Win 25-Year Awards

Headquarters Office
Edward J. Carter
Joseph C. Lacey, Jr.
Harriett A. McDannald
Paul R. Watson, Jr.
Wyatt C. Winkler

District I
Emil Wurche

District II
George R. Bradley
Paul K. Miles

District IV
A. G. Bertollozzi
Antoinette K. Casey
Aurora Douglas
Hugh G. Munro

District V
Thrale H. Milburn

District VIII
Leonard P. Heiner

District X
Charles E. Nuding

District XI
Aurelia B. Rinderneck

Bridge Department
August E. Dirckx

State-Owned Toll Bridges
John A. King

Headquarters Shop
Gertrude E. Haddick
John C. Tibbitts

Whiskeytown Fill

New Dam Requires U.S. 299 Relocation

By R. J. FELTON, District Construction Engineer



In January, 1960, Gibbons and Reed Construction Company of Salt Lake City, began the relocation of five miles of State Highway U.S. 299 through the historic settlement of Whiskeytown in Shasta County 11 miles west of Redding. An interesting feature of the project is the westerly approach embankment constructed for the crossing of Whiskey Creek.

Relocation of the existing highway became necessary with the advent of Whiskeytown Dam currently being constructed on Clear Creek 2 miles downstream from the townsite. The existing highway, as well as the townsite, will be inundated by a 3,250 acre lake storing 250,000 acre feet of water that will be created by the dam constructed as a portion of the Trinity River Project.

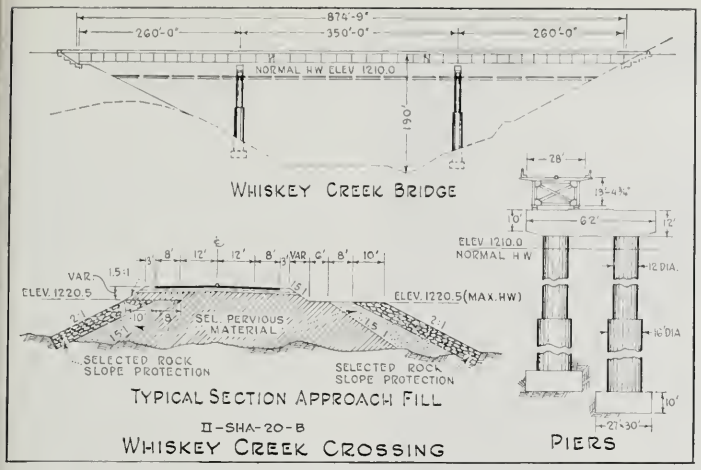
Was Control Point

Whiskey Creek is a tributary to Clear Creek and was the major control point in selecting the route for the highway relocation around the reservoir. The Whiskey Creek arm of the future lake offered a gap one-half mile wide and up to 190 feet in depth to be spanned.

The design selected consists of 875 feet of structure spanning the deepest portion and 1800 feet of embankment to serve as the westerly approach. The



Partly completed embankment across Whiskey Creek Arm viewed from west end. The benched cuts are on the east side of the creek.



Embonkment typical section and bridge profile.

embankment has a maximum height of 160 feet and will be submerged to a maximum depth of 140 feet. The submergence of the embankment subjects it to some of the hazards encountered in earth fill dams. Changes in internal hydrostatic pressure due to rapid decrease in water elevation had to be considered.

The design of the embankment is similar to that of an earth fill dam. The core is constructed of impervious soil encased in a shell of pervious rocky material protected by a 10-foot facing of selected rock on a 2:1 slope. The embankment contains a total of 1,220,000 cubic yards of material. The core contains 797,000 cubic yards and there are 330,000 cubic yards of selected pervious material and 93,000 cubic yards of selected rock slope protection in the outer layers.

All of the materials in the one embankment were obtained from roadway cuts and represent 44% of total earthwork on the project.

Tests Made

During the course of constructing the embankment, permeability tests were made on the selected pervious material to insure that the pervious zone will be free draining and devoid of internal hydrostatic pressure. The weight of the pervious material and rock slope protection is designed to prevent failure of the embankment core. During long periods of submergence the embankment will develop an internal hydrostatic pressure equal to the pressure of the water on the embankment. When the water level is drawn down rapidly the differential between the hydrostatic pressure within the impervious embankment core and the atmospheric pressure outside actually causes a tendency for the embankment to slump and fail.

The rock slope protection will also protect the embankment against wave action.

The constructed grade line on the embankment will be one foot higher than the planned ultimate grade to allow for subsidence of the original ground and settlement of the embankment due to submergence.

Two-lane Expressway

Basically the project consists of constructing a two-lane expressway to a 40-foot roadbed width. At the Whiskey Creek crossing the embankment width, up to maximum high water elevation, is designed to accommodate a future 4-lane 60-foot all-paved roadbed. The substructure of the bridge is also designed to accommodate 2 additional future traffic lanes.

In May, 1961, the earthwork on the project was 95% complete and work was in progress on the abutments and the two piers of the bridge. The plate girder type bridge has an unusually long center span of 350 feet.

Financing of the project is shared jointly by the Division of Highways and the U.S. Bureau of Reclamation. The Bureau's share of approximately 90% is based on a "replacement in kind" cost. The State's share of the cost of the new construction provides for greater width and superior geometric standards to those of the existing highway.

The project was designed by State personnel and construction engineering is provided by the State, with B. L. Borup and M. P. Brower as resident engineers. The project will be completed in the fall of 1961 at a cost of $4,200,000.

J. J. DuCray in New Administrative Post

Appointment of Justin J. DuCray as Senior Administrative Analyst in the Department of Public Works has been announced by Director Robert B. Bradford. He will perform the duties of the Departmental Management Analyst in the position held by John H. Stanford until his appointment as Assistant Director.

DuCray began his career with state government in 1947 as a field office manager with the Department of Employment. After holding several positions in administrative work with Employment, DuCray transferred to the Department of Public Works in 1957 as an associate administrative analyst.

WARMTH HELPS ROAD OPENINGS

The light snow pack and warm weather facilitated early opening of the high Sierra passes and other snow-closed roads, all of which were open by May 4 except the Lassen Loop Highway maintained by the National Park Service. Total snowfall for the season at Donner Summit amounted to 285 inches, with an 8-inch snow pack at the end of April. This compared with a 279-inch snowfall last season, with a similar light snow pack.

The California Highway Commission has allocated an additional $265,000 for reconstructing base and surfacing on sections of State Sign Route 1 between Davenport and Princeton in Santa Cruz County.

Accounting Modernizes

In building highways, as in virtually all phases of modern technology, there is a constantly increasing cost of producing the detailed and complex information about operations which is necessary as a guide for continued efficiency. Hand in hand with this problem of increasing costs, there has also been increasing delay in extracting the necessary facts and figures from the record keeping systems. Early in the research for possible revision of the accounting system, it was obvious that to provide current data as needed it would be necessary either to expand the cost distribution system and accumulate the additional information by the use of bookkeeping machines, or to abandon the present system in favor of data processing equipment with electronic speeds.

For more than a decade the Division of Highways has been using some form of electronic computer to perform engineering calculations, progressing from the more primitive early types to the highly complex ones now used. In the Planning Survey Data Processing Center, many thousands of man hours have been saved by the machines during that period.

It should be kept in mind that the hours saved were engineer man hours, which until the installation of the computers, would have been expended in operating calculating machines. Not only have the machines relieved the engineer so that he has time to do the design work he is trained for, but they also help him in his design work. The speed of calculation allows him to investigate a number of design solutions for a bridge, for instance, and quickly discard all but the best and most economical solution.



Martha Laird of Headquarters Office points to one of the latest type computer and storage bank machines already installed at Sacramento. The new accounting machines will record district information on tape which can be fed into this machine and others like it.

More Information Faster

To satisfy modern management's demand for more and more information with ever more refinements, many other big organizations have turned to the science of electronics for a solution. It was decided that the Division of Highways could best profit by the adoption of an automatic data processing system. The alternative would have involved the acquisition of additional bookkeeping machines, the hiring of additional personnel and the enlargement of physical facilities of the District Accounting Departments. Even with the expenditure of considerable additional funds, it was doubtful that such a system would be able to satisfy the ultimate demands upon it. In recent years it has become apparent that due to the problems of complexity and costs, further mechanization of a Division's accounting system would be warranted. Cost analysis, for instance, could not be readily furnished upon request except through costly and time-consuming post-analysis of the accounts.

Two Years Research

In the preliminary research which began in 1959 to find the best electronic system to take over the load, it was determined that only two types of in-put for automatic data processing would be suitable. The first method would require sending all source documents to Headquarters Office in Sacramento for key punching into the familiar punched card. The second would provide for data to be converted at the District level into a form acceptable to the Headquarters Office data processing equipment.

As planning for changeover progressed, considerable helpful advice was obtained from the Data Processing Center in the Planning Survey section which, of course, had a considerable fund of general experience with computers.

Where possible, changes in accounting procedure under consideration anywhere in the Division were considered in the light of applicability to a new system. For example, a change in the arrangement of code numbers on work orders was made effective July 1, 1960. The new number system was designed so it would fit smoothly into an electronic accounting system.

In January of this year a pilot study was put under way in District X, Stockton, to determine the effectiveness and practicability of creating the original data processing medium at the District level. An accounting machine with a punched paper tape by-product was chosen. While entries are being posted to conventional ledger cards, a punched paper tape is being produced showing the same entry, only in greater detail. The tape produced is then forwarded to Sacramento where the tape is converted to punched cards.



Lou Perez at Headquarters Accounting Department shows tape mechanism and storage reels on new type bookkeeping machines.

Accounting Machines Best

The results of the pilot study indicated that posting expenditure authorization ledgers in the District offices was both desirable and necessary in either system. The key punch method would require immediately at least sixteen additional key punch operators, and sixteen key punches and verifiers in Headquarters Office. The cost of key punch equipment and the salaries for additional employees was far greater than the cost of accounting machines with punched tape output and a tape-to-card converter. Using the accounting machines permits our present personnel to perform basically the same work they are now doing and for which they have been trained. Controls will still be maintained in the Districts where questions concerning accounting, coding and other matters can be answered immediately, thus eliminating communication problems between the Districts and Headquarters Office.

Accounting machines with tape outputs and a tape-to-card converter have been purchased. The accounting machines are being placed in the District offices for use on the normal accounting work and a punched tape record of the data will be produced automatically.

Conversion Starts Immediately

On July 1, 1961, the Headquarters, District, and Bridge Department accounting will be converted to the new system. Studies will be made for possible conversion to the new system of the Equipment Department, Materials & Research, Inventories, and Toll Bridge accounting. It is believed that the new system will provide management with all the data now required at high speed and at a saving in cost and that it can be expanded to meet future needs.



Left: Marian Ariff at District X Office at Stockton operating one of new machines, which are little larger than typewriter, need no special installation.

Needles

U.S. 66 Through Downtown Area Is Four-laned, Straightened

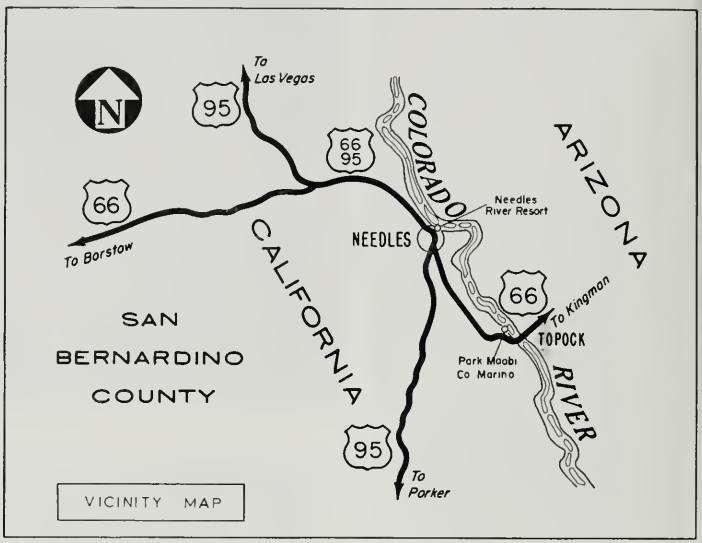
By L. M. BARNETT, Construction Engineer and C. M. MAUCK, Resident Engineer



In keeping pace with the City of Needles' expanding economy of tourism and recreation, local and interstate traffic has recently been provided a safer highway with increased capacity. The interim construction, pending a freeway bypass, was financed jointly by State Highway Funds, Major City Street Funds, and the City of Needles through an Assessment District. It was administered by the City.

This improvement is in sharp contrast to the transportation facilities of the early 1900's when transportation in the vicinity of Needles was by stern-wheeler boats (on the bordering Colorado River), railroad, horseback, and by a few automobiles utilizing dirt trails that had brought the covered wagons to California.

The Colorado River was the most formidable early barrier to traffic. To cross the river, several different types of transportation facilities were used in various combinations. For a while, a barge, pulled by a puffing motor ferry, carried cars across during limited times when river conditions were favorable. In high water, the river was too swift for a safe crossing, while at low water, even the shallow draft flat boats mired when carrying an automobile.



Planks Are Laid

The Santa Fe Railroad assisted these pioneer motorists by permitting planks to be laid alongside the rails on its nearby Topock Bridge. Autos were allowed to cross whenever the tower man signaled that no trains were coming from either direction.

After about 5 years, the increase in automobile usage made this operation too hazardous. In 1916, a steel arch bridge was erected at Topock for the



Looking east toward Needles showing new curb and gutter with surfacing striped for four lanes.

County road, which later became State Highway (U.S. 66).

During World War II, the Santa Fe built its present railroad bridge. The old steel span of 1889 became the highway bridge and the lighter steel arch of 1916 began serving as a cradle for a huge gas main.

The covered wagon trails were progressively widened and straightened, with oil eventually being added to settle dust. This expanded, in the 1920's, into the use of thin blankets of road-mixed asphalt surfacing. However, in 1959 the main highway through Needles, although paved, was not adequately handling the increased local and through traffic. The road consisted of badly broken pavement, steep gradients, and dangerously sharp curves. It was striped throughout for only two lanes; however, frustrated motorists frequently used portions as a narrow four-lane facility.

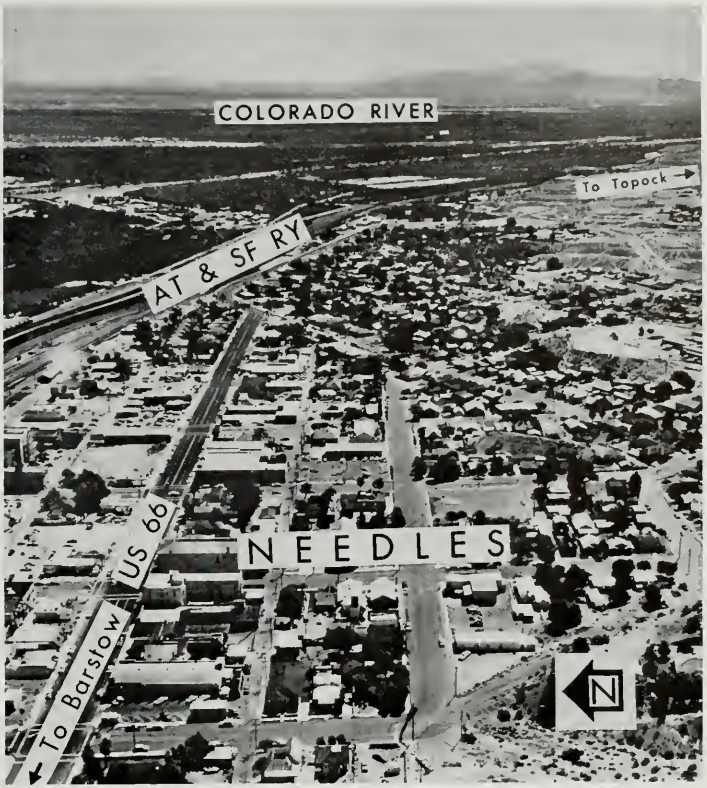
Through the cooperative efforts of City Administrators, a project, consisting of two contracts, was set up to improve this thoroughfare.

Example of Cooperation

This project, from the planning to the final construction stage, was a good example of cooperation between cities and the State. City personnel handled nearly all phases of the project from its inception to letting the construction contract and administration thereof. They prepared the plans and other contract documents, with the State furnishing assistance as to required standards and procedures, etc. The City also acquired the necessary right of way and handled the utility relocations.

The project added sufficient width to provide for four moving lanes, two parking lanes and curbs and gutters, and resulted in improved grade, horizontal alignment and superelevation. The roadway was blanketed with a smooth-riding surface of asphalt concrete.

Total project costs were approximately $210,000, shared as follows: $118,000 from State gas tax funds, $14,000 from City gas tax funds, and $78,000 from funds provided by an Assessment District following procedure provided for by the 1911 Bond Act.



An aerial of reconstructed U.S. 66 through downtown Needles.



Looking northwest toward Needles showing the widening of the roadway with improved grade and alignment.

City officials instrumental in setting up and administering the project include: H. L. Smith, Mayor; W. Jacobson, City Manager; J. R. Smith, Director of Public Works; Don C. Davis was consulting engineer. The State



The complete mobile asphalt concrete plant ready to roll.

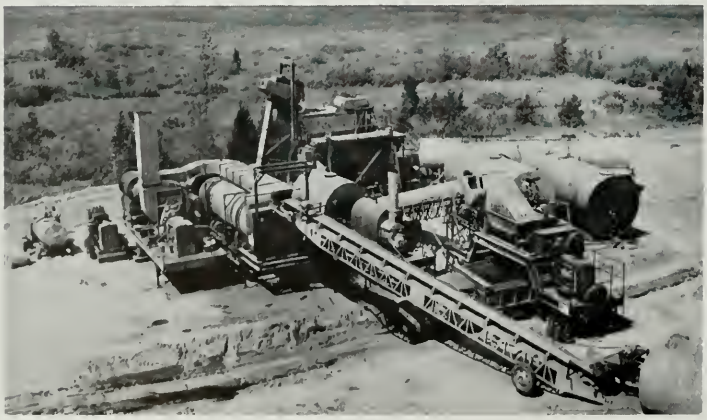
resident engineer assisted in inspection of paving operations at the request of the City.

Mobile Plant Used

The firm, Scott and Scott Contractors of Sun Valley handled the grading and paving, with C. Bode as superintendent. They used a highly mobile, 4,000-pound, batch-type, asphalt concrete mixing plant.

A summary of the more important features of this plant is:

1. Mobility Features
 Each major plant unit has permanently mounted transporting wheels.
 The plant is self-erecting with built-in hoisting equipment and hinged jack legs to assist in rapid dismantling and resetting. No crane is required.
2. Layout (See Plot Plan and overall photograph of plant).
 The plant is spread out close to the ground, in contrast to higher "stack-up" plants.
3. Capacity
 The manufacturer rates this Model 40 unit at 140 tons per hour. (A fair production check could not be obtained on this project.
4. Operation
 The entire feed and mixing cycles are controlled automatically, and can be operated by simply pressing one button. (The plant can be switched to manual operation as desired.) The pug mill receives the weighed aggregates by conveyor belt and the asphalt by an automatic volumetric calibrating device (fluidometer), after which the materials are mixed a predetermined length of time and then discharged into the trucks. The automatic cycle control prevents other than a predetermined amount of aggregate and asphalt being used in the mix. A weight check of the volumetric measurement made by the fluidometer indicates it is quite accurate. (It should be considerably more accurate than the batch-weighing method.)



Typical layout of the mobile aspholt concrete plant.

Although a test of the full potential of this plant was not possible due to the short sections of this project, it seems to have definite advantages in its mobility and self-erecting features.

The City Administrators of Needles have also worked cooperatively with State and Federal personnel to locate the route of the future interstate freeway, complete with modern-type interchanges, through the City of Needles.

While these modern freeway plans are being developed, the newly improved highway facility should safely and comfortably accomodate the tourist who has already discovered this desert wonderland.

The State Department of Public Works has awarded a $873,000 contract to construct a mile of freeway and the Ethanac Overhead and Interchange on U.S. 395 east of Perris in Riverside County.

Asphalt Test

Ten Different Road Samples Show Varying Durability

By ERNEST ZUBE, Supervising Materials and Research Engineer

INTRODUCTION

THE CALIFORNIA Division of Highways has for a good many years been interested in the quality of paving asphalts.

This paper was presented at the Tenth Arizona Roads and Street Conference, Tucson, Arizona, November 17-18, 1960.

It has been our observation that many asphalt pavements after a comparatively few years of service have shown signs of distress in the form of cracking, ravelling and general evidence of becoming brittle.

Crude petroleum in California is produced in three major areas: The Los Angeles Basin, the Kern Basin and the Santa Maria area. Asphalts from the Los Angeles and Kern area are somewhat similar in properties, but asphalt produced from the Santa Maria area exhibits somewhat different characteristics. Although the engineer is concerned with several properties of the asphalt, certainly the most important is durability. The materials and Research Department has been working on the problem seeking to develop testing methods and test limits that would exclude asphalts having a poor durability record. As a result of this work, a trial specification was developed in 1954 which has been referred to at times as the specification for "premium" asphalt. In order to determine the performance of asphalts complying with the new requirements, it was decided to place a series of test sections commonly known as the Zaca-Wigmore test road.[1] Actual construction took place during 1954 and 1955. Ten different asphalts were used. Failures have developed in some of the sections while others are still in quite good condition. It must be emphasized that these marked differences in performance exist even where all conditions of construction, aggre-

FIGURE 1

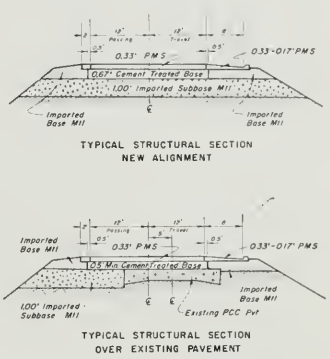


FIGURE 2

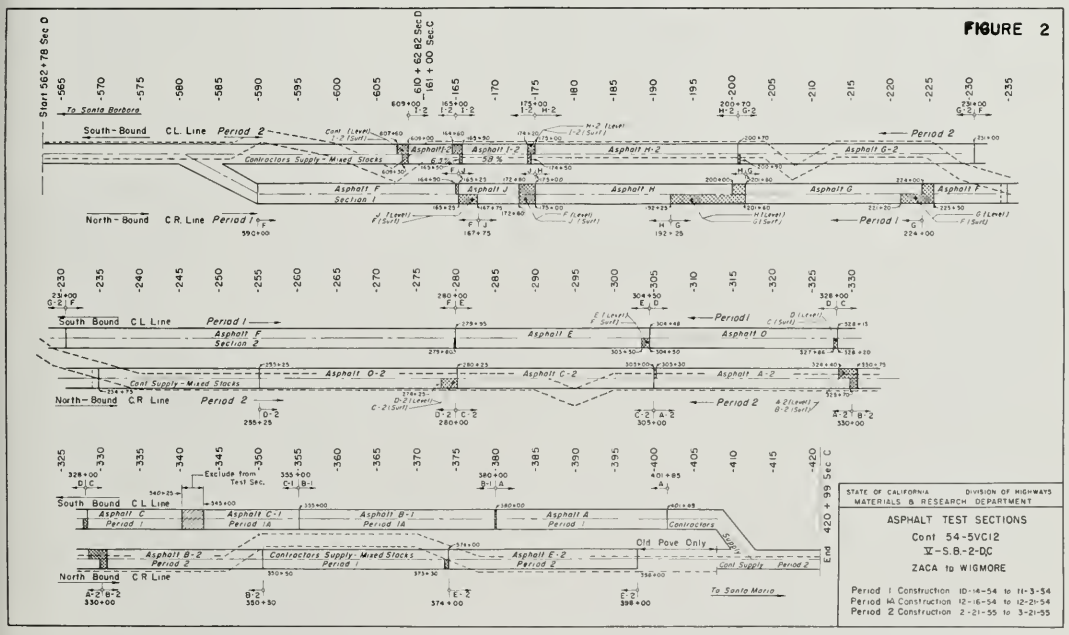


TABLE I

Average Paving Mixture Test Properties of Laboratory Compacted Specimens

	Paving Period	
	I, IA	II
Per Cent Asphalt Used	5.5	5.8
Per Cent Asphalt Extracted	4.7	5.0
Spec. Grav.	2.16	2.21
Stab. 140°F.	41	42
Cohesion 140°F.	142	246
Swell (Inches)	0.002	0.003
Grading—% Passing:		
¾	100	100
½	87	85
⅜	76	70
4	59	51
8	48	39
16	40	32
30	30	24
50	18	15
100	9	9
200	6	6

gates and quantity of asphalts were quite similar.

Project Description

The project is located on U.S. 101 in Santa Barbara County, about 150 miles northwest of Los Angeles and, to the best of the author's knowledge, is the largest experimental asphalt installation of its type in the world. Zaca and Wigmore were originally stations on the now abandoned Pacific Coast Railroad. Although these stations are no longer in existence the names serve to identify the termini and the job is now referred to as the Zaca to Wigmore test road.

The project consisted of converting an existing two lane highway into a four lane divided expressway by constructing two new lanes and widening the existing pavement.

Based on soil surveys and an anticipated ten year traffic estimated weight load of 10.7 million, the structural typical section for the new alignment consisted of 1.0′ imported base material, 0.67′ of Class B, cement treated base and 0.33′ plant mixed surfacing (asphaltic concrete) Type B.

The existing facility constructed in the early 30's consisted primarily of an old P.C.C. pavement and was in fair to poor condition. The new design provided a minimum of 0.5′ Class B, cement treated base to be placed over the present pavement and to be surfaced with 0.33′ of asphaltic concrete. The existing concrete pavement was subsealed with asphalt prior to placing the new cement treated base. The roadway was widened to provide a geometric section similar to the new construction. The typical sections for both new and existing pavements are shown in Fig. 1.

TABLE II

Average Properties of Pavement Cores Removed from the Outer Wheel Track of the Travel Lane

Asphalt	Paving Period	Age Mo.	Relative Density Per Cent	Weight Per Cu. Ft. Lbs.	Per Cent Voids	Per Cent** Relative Compaction	Stability	Cohesion 140°F
A	I	59	93.7	138	6.3	102.2	38	249
A-2	II	55	97.9	142	2.1	104.1	32	289
B-1	IA	57	95.9	141	4.1	102.6	35	425
B-2	II	55	94.9	138	5.1	100.0	32	408
C	I	59	93.2	137	6.8	101.4	38	239
C-1	IA	57	96.6	142	3.4	105.1	24	328
C-2	II	55	96.2	140	3.8	102.3	29	339
D	I	59	93.7	138	6.3	101.3	39	175
D-2	II	55	97.1	141	2.9	101.8	34	242
E*	I	35	89.8	132	10.2	99.1	26	249
E-2	II	55	95.4	138	4.6	100.8	33	553
F*	I	35	91.4	134.5	8.6	101.0	35	141
G*	I	35	90.9	134	9.1	99.8	33	314
G-2	II	55	95.4	138	4.6	100.4	34	535
H	I	59	93.2	137	6.8	101.4	36	110
H-2	II	55	97.4	142	2.6	102.3	30	277
I-2—5.8%	II	55	95.7	139	4.3	101.3	39	645
I-2—6.3%	II	55	97.1	141	2.9	101.3	31	494
J	I	59	91.1	134	8.9	100.5	35	217

* These sections failed between 35 and 59 Mo.
** Per cent relative compaction based on laboratory compaction equals 100%.

Layout of Test Sections

It was decided to place the test sections in duplicate and make them as long as possible. A long test section has a definite advantage in that it provides average conditions of construction and also provides a better basis for future comparison of performance. Whenever possible, the test sections were placed so that asphalt from the same refinery would be used in two locations—one on the new alignment and one section over the existing pavement.

A final test section length of approximately 2500′ for each asphalt was selected, with the exception of two special asphalts where the available supply prevented the placing of duplicate and full length sections.

Selection of Asphalts

Considerable thought was given to the grade of paving asphalt to be used on the project and finally the 200-300 penetration grade was selected, the reason being that the district in which this project was planned had used this grade on previous projects to the north and south of the test project on Route 101, and thus permit a comparison of the performance of the test asphalts with other 200-300 penetration grades.

TABLE III
Specifications for Paving Asphalts

Specification Designation	1954 Standard Specifications		1954 Special Provisions	
	A.A.S.H.O. Test Method	Specification Requirements	A.A.S.H.O. Test Method	Specification Requirements
Flash Point, Cl. O.C. °F., Min.	T48	350	--	--
Flash Point, P.M.C.T. °F., Min.	--	--	T73	400
Penetration of Original Samples, 77°F.	T49	200-300	T49	200-300
Loss on Heating, 5 Hr. at 325°F., % Max.	T47	3.0	T47	1.0
Penetration After Loss on Heating, % of Original, Min.	T49	60	T49	75
Original Ductility at 77°F., cm., Min.	T51	100	--	--
Penetration Ratio: Pen. 39.2°F—200 gm—1 Min. / Pen. 77°F—100 gm—5 Secs. × 100	--	--	T49	25 Min.
Furol Viscosity at 275°F., Sec.	--	--	--	40-125
Solubility in CS_2, % Min.	T44	99.5	--	--
Solubility in CCl_4, % Min.	T45	99	T45	99
Xylene Equivalent, % Max.	Sec. 6 Chap. II Std. Spec.	35	T102	30

At the time the test section was proposed, the Materials and Research Department was engaged in the preparation of new specifications for paving grade asphalts. It was decided to obtain asphalts (meeting the new specification requirements) from the three principal crude sources in California which would also include different methods of production. In order to compare these new specification asphalts with those conforming to our 1954 Standard Specifications, two asphalts meeting the 1954 Standards were selected from different crude sources. One of the asphalts had very good test properties while the other just barely complied with the old 1954 requirements.

Our research studies indicated that certain asphalts produced from Mid-Continent crudes have superior durability characteristics when compared to California asphalts. In order to aid in the further evaluation of test methods under development, it was decided to obtain one railroad car of 40 tons from a producer using an Arkansas crude.

The project as finally constructed, is shown in Fig. 2. It contains six asphalts complying with the then new special provisions (frequently referred to as "Premium" specifications), two asphalts complying with the requirements of Section 54 of the 1954 Standard Specifications and two asphalts not commercially available in California at the present time, but placed in order to aid in the evaluation of new test procedures. The asphalts used on all portions outside the limits of the test sections consisted of either asphalt F or a mixture of the various asphalts on hand. The following table lists the asphalts and specification designations.

State of California Code Construction Period			*Specifications*
I	*IA*	*II*	
Asphalts Used			
A	--	A-2	Special Provisions
	B-1	B-2	"
D		D-2	"
F			"
G	--	G-2	"
H		H-2	"
C	C-1	C-2	1954 Standard Specifications
E	--	E-2	"
		I-2(5.8)	Special
		I-2(6.3)	
J	--	"	"

Fig. 3

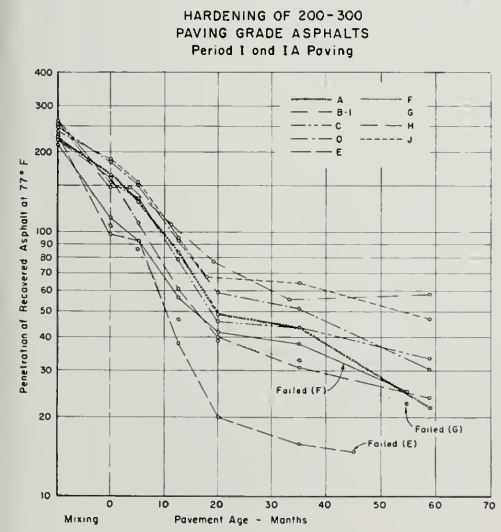


Fig. 4

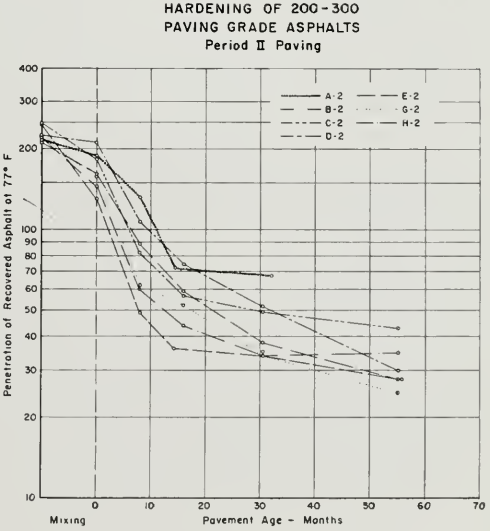


Fig 5

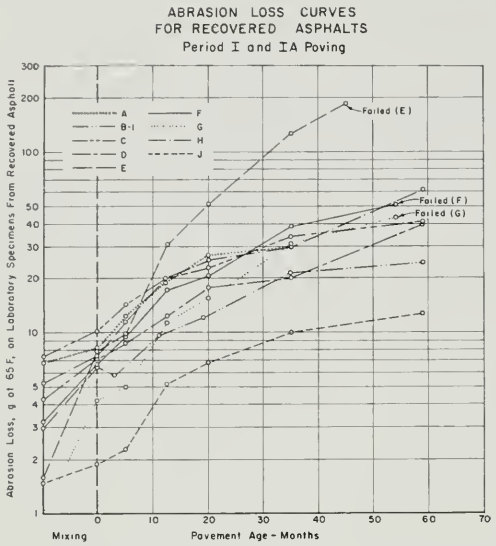
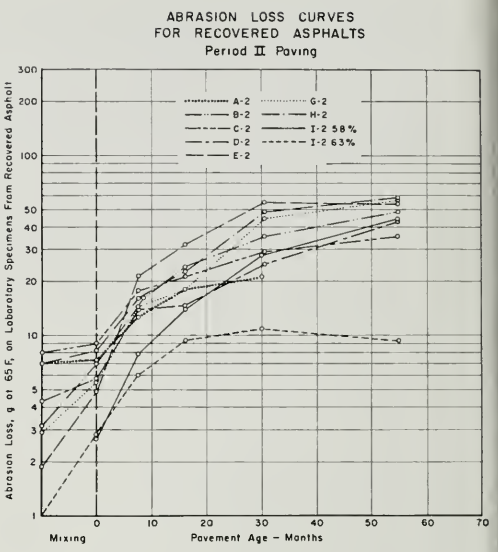


Fig 6



Construction Operations

Construction operations on this project were somewhat complicated by the necessity of carrying traffic through the job site. After completion of subbase and cement treated base operations over the major portion of the new alignment paving began in October 1954 and was completed in November. This portion of the paving is designated as Period I. The remainder of the new alignment was paved in December and is called Period IA. Following completion of the new alignment, work began on the existing pavement and paving operations were performed in February and March 1955. This portion of Construction is designated as Period II.

The pavement throughout this project consisted of 0.33' of plant mixed surfacing (asphaltic concrete) Type B placed in two lifts and conformed to the requirements of Section 20 of the 1954 Standard Specifications.

The aggregate source was a streambed deposit on the Santa Ynez River about ten miles from the job site. Processing was done in a portable crushing and screening plant.

TABLE IV

Average Deflection Readings in 0.001" With 15,000 lbs. Axle Load, for Asphalt Test Sections

Period I and IA Paving Over New Alignment — Period II Paving Over Existing Alignment

	Average Deflection Outer Wheel Track-Travel Lane								
Paving Period	April 1955	Dec. 1955	May 1956	March 1957	Nov. 1957	April 1958	Nov. 1958	April 1959	April 1960
Age-Mo.	5	13	18	28	36	41	48	53	65
I	12	12	10	10	9	17	13	16	19
Age-Mo.	4	12	17	27	35	40	47	52	64
IA	19	15	12	13	9	17	13	18	17
Age-Mo.	1	9	14	24				49	61
II	14	11	7	6				10	11

The paving mixture was prepared in a standard plant with aggregate temperatures maintained at 290°F. An asphalt content of 5.5% by dry weight of aggregate was used during Periods I and IA and 5.8% during Period II. Due to the variety of asphalts used, four separate tanks were provided for asphalt storage. The complexity of paving operations can well be imagined with as many as five changes in asphalt sources in a working day.

The level course was laid with a spreader box and blade. The surface course was placed with a self-propelled mechanical paver. Rolling of the level course was performed with a pneumatic and tandem roller, the surface course was compacted with a 10 ton steel tired tandem.

Average laboratory test results on field samples of the paving mixture for the various paving periods, are shown in Table I. Of interest is the finding that the specific gravities of laboratory compacted samples were consistently higher during Period II operations when compared to Period I and IA which is undoubtedly due to the increase in asphalt content.

All of the pavement was fog sealed at the end of Period II paving operations and traffic was routed over all lanes on March 30, 1955.

Performance Evaluation

Since opening to traffic periodic inspections for visually rating the service behavior of the respective test sections have been made by members of the Materials and Research Department, as well as detailed field and laboratory investigations. The following topics will be presented at this time.

1. Properties of pavement cores removed at various time intervals.
2. Changes in the original properties of the various asphalts recovered from the cores by means of the Abson Process.
3. Deflection studies.
4. Surface surveys and crack mapping.
5. Distress which has occurred up to date in certain sections.

1. Physical Properties of Pavement Cores

The physical properties of pavement cores up to 59 months service life are shown in Table II.

Although Period II paving was performed at lower ambient temperatures, it appears that the additional 0.3% asphalt in the mix permitted better compaction. The lower void content of the compacted mixture and heavier film thickness provided by the additional asphalt in Period II paving should lead to a lower rate of weathering.

2. Changes in the Original Properties of the Various Asphalts

Seven refineries furnished asphalt complying with the 1954 Special Provisions specifications, (which were somewhat different from our present 1960 Standard Specifications) and two additional sources furnished asphalt, complying with the 1954 California Standard Specifications. Specifications are shown in Table III. Asphalt I-2 did not have any specified requirements.

It will be noted that the drop in penetration, shown in Fig. 3 and 4 definitely indicates that less hardening occurred during mixing in Period II than in Period I for all of the asphalts.

The change in penetration and abrasion loss [2] for approximately 4½ to 5 years of service life are shown in Fig. 3, 4, 5 and 6. The curves showing drop in penetration, provide the normally expected shape, with a rather rapid increase in hardening during the first 16 to 20 months and a tendency to decrease thereafter. It is important to note that the slopes of the curves beyond the 16-20 month breakpoint must be confirmed by additional tests. If such slopes tend to remain parallel for the different asphalts, then the hardness of the material at the 16-20 month breakpoint becomes a fundamental criteria for asphalt durability, since the ashpalt having the highest retained penetration at this point should have the longest future service life.

It is interesting to note that extensive failures have occurred in the F, G and E Period I sections. It appears that a combination of drop in penetration into the 20-30 range coupled with a marked drop in ductility and gain in abrasion loss may signify serious paving failures when moderately

Fig 7

CHANGE IN PENETRATION AND ABRASION LOSS FOR ASPHALT I-2

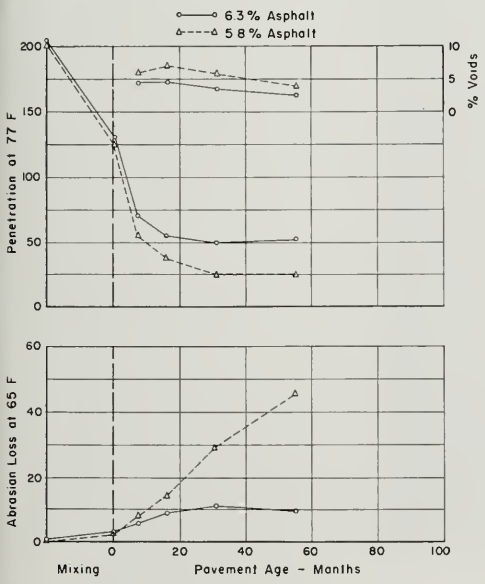
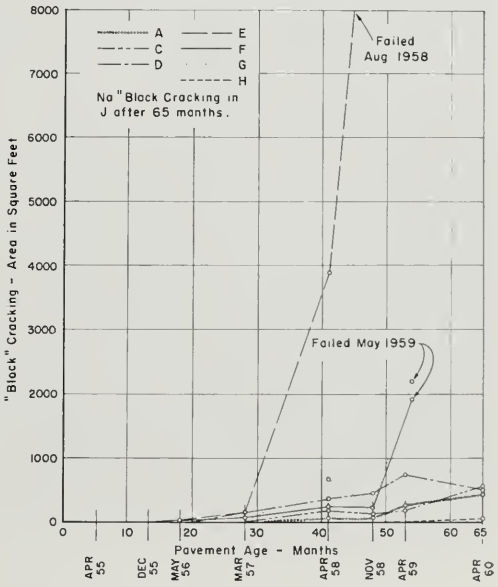


Fig 8

"BLOCK" CRACKING IN ASPHALT TEST SECTIONS OVER NEW ALIGNMENT



high pavement deflections are encountered.

In the case of asphalt I-2, two asphalt contents 5.8% and 6.3% were used for adjacent test sections. The difference in asphalt content did not appear to be reflected in either the penetration drop or abrasion loss gain during mixing, but has produced a quite radical difference during pavement service life, see Fig. 7. These results confirm other reported findings that the weathering rate is affected by film thickness.

3. Deflection Studies

The average deflections for all paving periods, taken in the outer wheel track of the travel lane, are shown in Table IV. Deflection readings were also taken in the inner wheel track and the passing lane, but as literally thousands of measurements were taken, only the outer wheel track data are shown. This area of the pavement is generally considered the most critical one and the most indicative of the adequacy of the structural section.

In all periods there has been a gradual decrease in deflections up to approximately November 1957, or three years after construction. Apparently, consolidation of the various layers, has led to this decrease.

Following the readings in November 1957, the trend in deflections on the new alignment was definitely reversed. The spring readings following the severe wet winter of 57-58 showed a marked increase.

4. Surfacing Rating Surveys and Crack Records

The evaluation of service performance of the various test sections has been based not only on the results of tests on cores removed at various intervals, but also on visual observations and crack surveys.

About one year after completion of construction the surface of the pavement laid during Periods I and IA began to appear lighter in color and dry in appearance. The only section that did not show this early change in appearance was asphalt J. The lighter appearance of the surface is undoubtedly due to the nature of the aggregate. Many of the particles are light in color and the asphalt tends to wear off the surface thus providing an appearance of dryness. Actually, cores that have this surface appearance are quite black just below the surface.

One very significant index of pavement performance on this or any other roadway is the appearance of "block" cracking which invariably leads to major maintenance operations. The pavement laid over new alignment shows considerable block cracking, Fig. 8. This form of cracking is virtually nonexistent over old alignment after 65 months of service life and this is to be expected because of the extremely heavy structural section which results in quite low average deflections.

Of great interest is the excellent correlation between the definite increase in "block" cracking of the travel lanes in a number of sections and the marked increase in average deflection in April 1958. This "block"



The junction between Asphalts D (foreground) and E (background) after 45 months of service life. Note spalling along longitudinal crack in the E section.



Typical condition of the major portion of the Asphalt E travel lane is shown here after 45 months of service life.

cracking coupled with severe raveling has led to total failure in sections E, F and G. We note that the passing lanes are virtually free from "block" cracking. This, of course, is consistent with the pattern observed in our many previous investigations of this type of failure on other highways.

5. Failures

Three test sections over the new alignment, paved during Period I operations, have been classified as failures and now require major maintenance.

The first section to show extreme distress was that paved with asphalt E. The very rapid hardening of this asphalt caused a very marked increase in "block" cracking between 28 and 41 months of service life followed by an extremely rapid increase in the following four months, Fig. 8, 9 and 10. The situation in August 1958 became so serious that it was necessary to place a slurry seal over the travel lane in order to carry the section through the winter of 58-59. It is apparent from a study of the "block" cracked areas in the G and F test sections, Fig. 8, that the E section could have been classed as a failure approximately three years after construction or about October 1957. At this time the test properties of the asphalt were: Penetration =16, softening point = 151°F, ductility = 16 cm. and Abrasion loss at 65°F = 128 gms.

The G and F sections were classified as failed in May 1959. During the fall of 1958 the G section appeared very dry and exhibited a fair amount of raveling. The F section was in quite good condition except for severe longitudinal cracking in one fill area approximately 500′ in length. The next survey, in February 1959, revealed a striking difference from the Fall appearance. There was extensive "block" cracking in the travel lane throughout both sections and severe raveling extending into the passing lane. There was not as much evidence of spalling as found during the stages of progressive failure in the E section. Failure investigations were performed in May 1959 and the results are shown in Table V.

The proposed maintenance of the three sections involved the placing of a screening seal coat. However, it should be stressed that if the failure in any one of these sections would have occurred on a normal roadway, it would be necessary to lay a 2″ to 3″ thick asphalt concrete blanket in order to provide a proper wearing surface. The present seal coat program is only a temporary expedient in order to permit continued observations of the remaining test sections.

CONCLUSIONS

The various asphalts, placed in the test sections, are weathering at different rates, but all show a tendency toward a definite decrease in the rate of developing hardness or brittleness beginning after approximately 16 to 20 months of service life.

However, due to the two different construction periods, somewhat different structural sections, accompanied by other unavoidable variations it is strongly recommended that the asphalts laid in Period I be distinguished from those laid in Period II. In other words, we should consider that we have two separate test roads and comparisons between test sections should only be made within each test road.

The performance of the Zaca-Wigmore test road, to date, clearly shows that asphalts manufactured from different crude sources and methods of production can have various degrees of durability under equivalent conditions of traffic and climate. The early failure of asphalt E, which just barely met our 1954 Standard Specifications and would fall far short of our present

TABLE V

Recovered Asphalt Properties from Failed Test Sections Laid Over New Alignment

Asphalt	Age Mo.	Penetration 77°F	Softening Point	Ductility 77°F	Abrasion Loss-65°F
E	45	10	161	5	182.4
F	54	25	144	Very erratic Ave. = 48 Range = 7-83 on 9 cores	51.9
G	54	23	154	8	42.7

requirements, confirms other evidence that the previous Standard Specifications permitted the use of asphalts of poor durability with a comparatively short service life. The failure in the G and F test sections and other recent failures of asphalt roads in our highway system indicates that even our present specification requirements are still not sufficiently restrictive to guarantee a durable product. Obviously it will be necessary to continue to make laboratory and field studies with the objective of developing test methods and specifications which will effectively exclude non-durable asphalts.

Acknowledgments

A project of this magnitude requires the cooperation of many individuals, and it is not possible to mention all of the personnel of the California Division of Highways and of organizations that contributed to the successful completion of the test road, and the continuing studies on performance during its service life.

The work was performed under the general direction of F. N. Hveem, Materials and Research Engineer. The writer wishes to especially acknowledge the efforts of Mr. John Skog in collecting and analyzing much of the data.

Reference

(1) "Progress Report on the Zaca-Wigmore Experimental Asphalt Test Project" by F. N. Hveem, Ernest Zube and J. Skog. California Division of Highways. Presented at the Third Pacific Area National Meeting of ASTM, San Francisco, October 11-16, 1959. Symposium on Road and Paving Materials. ASTM Publication No. 277.

(2) "The Operation, Control and Application of the Infrared Weathering Machine—California Design" by John B. Skog, California Division of Highways. Presented at the Second Pacific Area National Meeting of ASTM, Los Angeles, September 17, 1956. ASTM Publication No. 212.

Bids have been received by the State Division of Highways on the resurfacing of 7½ miles of State Sign Route 89 in Mono County between the Alpine County line and U.S. 395. Low Bidder was the Thomas Construction Company, Fresno, $313,313.

L. D. Wanee Plans August 1 Retirement

Lessley D. Wanee, Assistant Construction Engineer for the California Division of Highways, will retire on August 1 after 32 years of State service.



Lessley D. Wanee

Wanee joined the Division in 1929 as a Senior Engineering Aid in San Bernardino. All of his subsequent service until 1955 was in the San Bernardino area where he advanced through the engineering ranks, being appointed design engineer of District VIII in 1947. He supervised the designing of the City Creek Road reconstruction in the San Bernardino Mountains, the first freeways in San Bernardino and Riverside Counties and the three-level U.S. 99-395 traffic interchange south of the City of San Bernardino. He was promoted to his present post and transferred to Sacramento in 1955. In addition to field review of highway construction in various parts of the state, he has been active in the revision of the Division's Standard Specifications.

A native of Denver, Colorado, Wanee attended public schools in San Pedro. He studied for two years at the University of California at Los Angeles, transferring to the Berkeley campus where he received his engineering degree in 1929. He is a member of the honor society, Chi Epsilon.

An ardent tennis player Wanee was senior singles champion of Arizona four times, senior doubles champion twice and has won more than 40 tennis trophies in tournament play. Wanee and his wife, Alice, were mixed doubles champions of Sacramento City in 1959. Mrs. Wanee is past Sacramento City and County champion.

Wanee is a member of the American Society of Civil Engineers, the Sutter Lawn Tennis Club and the South Hills Racquet Club.

Following his retirement Wanee will live in Vista, California, where he will do engineering consulting work and raise avocados.

Retirements From Department Listed

Headquarters Office

Rodney F. Reynolds, Supervising Engineer, 42 years.

District III

Harry H. Sharp, skilled laborer, 27 years.

District IV

Charles M. Barnes, Highway Foreman, 35 years; Stephen V. Gelter, Assistant Highway Engineer, 7 years.

District V

John G. Kehrer, Highway Equipment Operator-Laborer, 36 years.

District VI

Oliver F. Keough, Highway Equipment Operator-Laborer, 18 years.

District XI

James B. Elliott, Highway Equipment Operator-Laborer, 30 years.

Shop 8

Roy Cravens, Automobile Mechanic, 18 years.

IN MEMORIAM

District IV

George Phillips, Highway Engineering Technician I.

District VIII

Ernest L. Walker, Laborer.

Bridge Department

John E. Burke, Associate Bridge Engineer.

State-Owned Toll Bridges

Lonnell D. Smith, Toll Collector.

Shop 4

Dale Leake, Heavy Equipment Mechanic.

Bids have been received by the Division of Highways on the realignment of Pescadero Road between U.S. 101 and Pescadero Creek in San Mateo County. Low bidder was Bragato Paving Company and Bellshore Corporation, Belmont, $199,521.

Geer Road

New F.A.S. Bridge Cuts Travel Distance 4½ Miles

By ELLIS R. DELBON, Road Commissioner, Stanislaus County

In October, 1960, the Stanislaus County Board of Supervisors accepted the largest highway improvement project ever undertaken by the County.

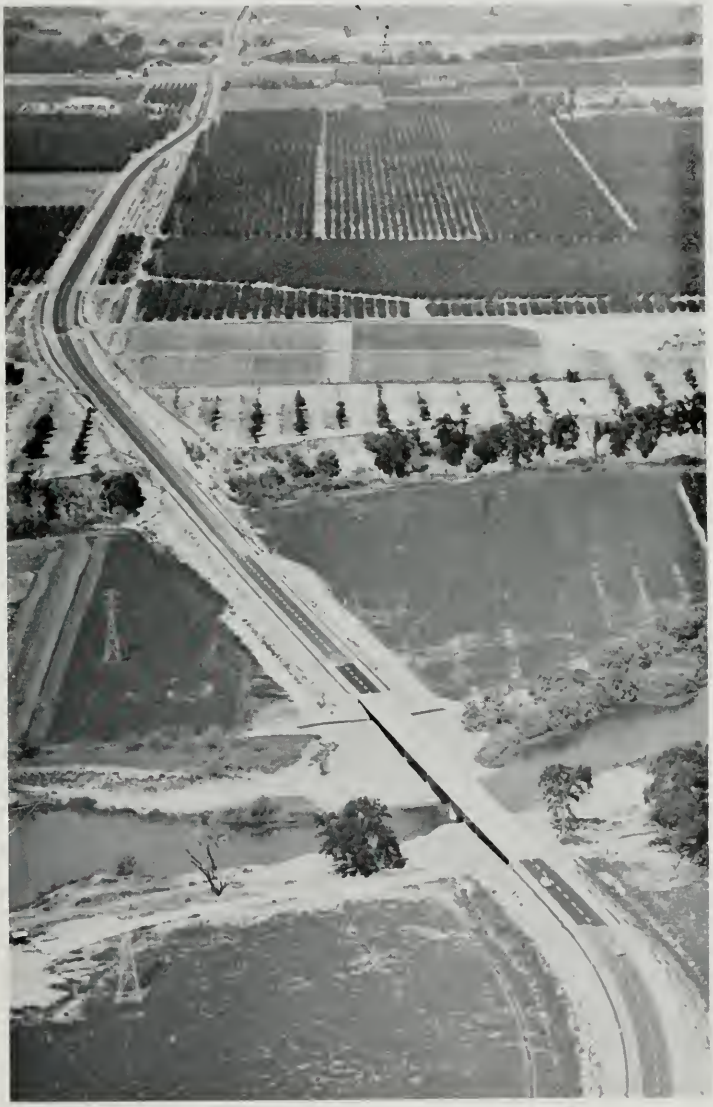
Opening of the new Geer Road Bridge over Tuolumne River was attended by many local dignitaries and representatives of the Division of Highways. The bridge is a portion of 2.1 miles of construction on entirely new alignment on FAS Route 914, which reduces travel distance between Turlock and Oakdale by 4.5 miles. It is the 10th major highway improvement project completed under the current 10-year capital improvement program approved by Stanislaus County Board of Supervisors in 1957.

Construction plans for this high standard two-lane highway were prepared by Stanislaus County with the contract being let late in 1959 by the State Department of Public Works under the Federal-aid Secondary Highway Program. Construction engineering and inspection was by County personnel.

Roadway construction involved grading and paving 1.96 miles. The road is surfaced with asphaltic concrete providing two 12-foot lanes and 8-foot paved shoulders. The Tuolumne River Bridge is a reinforced concrete box girder structure. It is 656 feet long, consisting of five 100-foot spans and two end spans 75 feet long supported on concrete piers and abutments on concrete piles. The clear roadway width is 28 feet between curbs and steel railings.

The total construction cost of the project is $513,000, not including preliminary engineering and right-of-way.

The County's capital improvement schedule includes improvement of five FAS routes and other County primary roads and bridges. The program is financed by appropriations from the County $5,000,000 bond fund approved in 1956, State Highway Users Tax Funds, and FAS Funds.



Geer Road in Stanislaus County between Turlock and Oakdale which was recently constructed under the Federal-aid Secondary and County Bond Program. The bridge in the foreground is over the Tuolumne River. (Modesto Bee photo)

California Roadsides—3

EDITOR'S NOTE: This, the third in a series of articles on landscaping and related roadside problems on the California State Highway System, covers the maintenance of landscaping and roadsides under today's policy and practices. The next and final article will cover the plants used today by the Division of Highways Landscaping Section, and why these choices have been made. The four articles will be made available to interested persons as a reprint booklet under single cover.

The series has been prepared by John Robinson of the Public Information Section with the assistance of various staff members concerned with planning, planting, and maintenance of roadsides.

It has been shown how the earliest road maintenance problems were those of mud and dust, and that the roadside tree was helpful in controlling these problems. Later, with straighter roads and modern design, slope control also became a problem. With the gradual refinement of the automobile as our main means of transportation, many new maintenance problems have developed. Here are some of these modern developments which have complicated roadside maintenance.

Today's cars are faster, longer and lower. This kind of automobile requires a different kind of highway from the one used by the famous Model-A Ford with its high clearance, good visibility, and short wheelbase. A driver of today's car is unable to see over slight rolls in the terrain, and his speed demands more sight distance on curves for safety. Nor can he easily negotiate sharp curves even if he can see around them, because of his car's speed, weight, and long wheelbase.

To a great degree, therefore, today's highways are dictated by automotive design engineers in Detroit. To be safe for today's vehicles, highways must be broad, with gentle, wide-sweeping curves. Rises must be cut down, and dips brought up to grade, so today's low seated driver can see far ahead. This kind of highway goes *through* the terrain instead of following land contours as the stagecoach roads did. Obviously, there must be more cuts and fills than ever. These countless new slopes create new problems of settlement, slippage, and disturbance of esthetic values. It is necessary, too, that obstructions such as bridges and interchanges on these new high speed highways be clearly delineated.

Smokers are another problem. Highways today must be considered a fire menace to every dry field and forest they border, for although it is against both common sense and the law, every day thousands of smokers carelessly throw lighted cigarettes and matches from cars. This is a more difficult problem than the spark problem of the early day railroads, which was solved by screens over the stacks of the locomotives.

Another relatively new maintenance job is the care of headlight screen planting in the median. With today's high speed vehicles bright headlights are needed, which in turn blind the drivers of oncoming vehicles. The best solution to this problem so far devised is the erection of some obstruction between the opposing lanes of traffic. On most highways in California the cheapest and most decorative solution is a living barrier of shrubs.

Then there is litterbugging—not exactly a new problem, but today many times magnified over what it was a generation ago, primarily because our technology has developed marvelous packaging of our foods, tobacco products, and beverages. Unfortunately, this packaging is usually partly or entirely of paper (except in the cases of beverages, when it is tin, glass, or waxed cardboard). Furthermore, everybody is constantly deluged with newspapers, magazines, direct mail advertising, and dozens of other kinds of printed matter. Most of these things are of temporary value, and are too frequently disposed of on the highway, although this too is illegal.

As previously pointed out, the judicious use of plants and landscaping techniques can assist the highway engineer in solving, or at least alleviating, these and other problem conditions. But the planting itself is only the first step. When the landscape contractor has finished his job, the maintenance man starts in. And as with many other expenditures, both public and personal, "it isn't the initial cost, it's the upkeep".

"ROADSIDE MAINTENANCE IN STANISLAUS COUNTY IN 1895"

"It is the custom to cover the roads in the summer season with refuse straw, which is abundant. This the most temporary makeshift. The cost of this strawing varies from $40 to $45 per mile, and in many instances must be repeated two or three times a season. Nor is this all. It frequently happens that a lighted match or cigar is dropped on a freshly strawed road, and the whole roadway vanishes in smoke. It is a well-authenticated fact that, on one occasion on the day after a road had been strawed, a band of hungry cattle came along and actually ate the road up."—From the 1895-96 Report of the California Bureau of Highways.

These are some of the activities and considerations involved in roadside planting maintenance:

● **Median plantings:** As previously stated, the Division of Highways landscape architects are in unanimous agreement that the most practical shrub for median planting for headlight screening is the oleander. But despite its hardiness, it must be watered for several years after planting;

it must be pruned in locations where it affects sight distances; litter must be cleaned from around it; and it occasionally must be replaced after an accident.

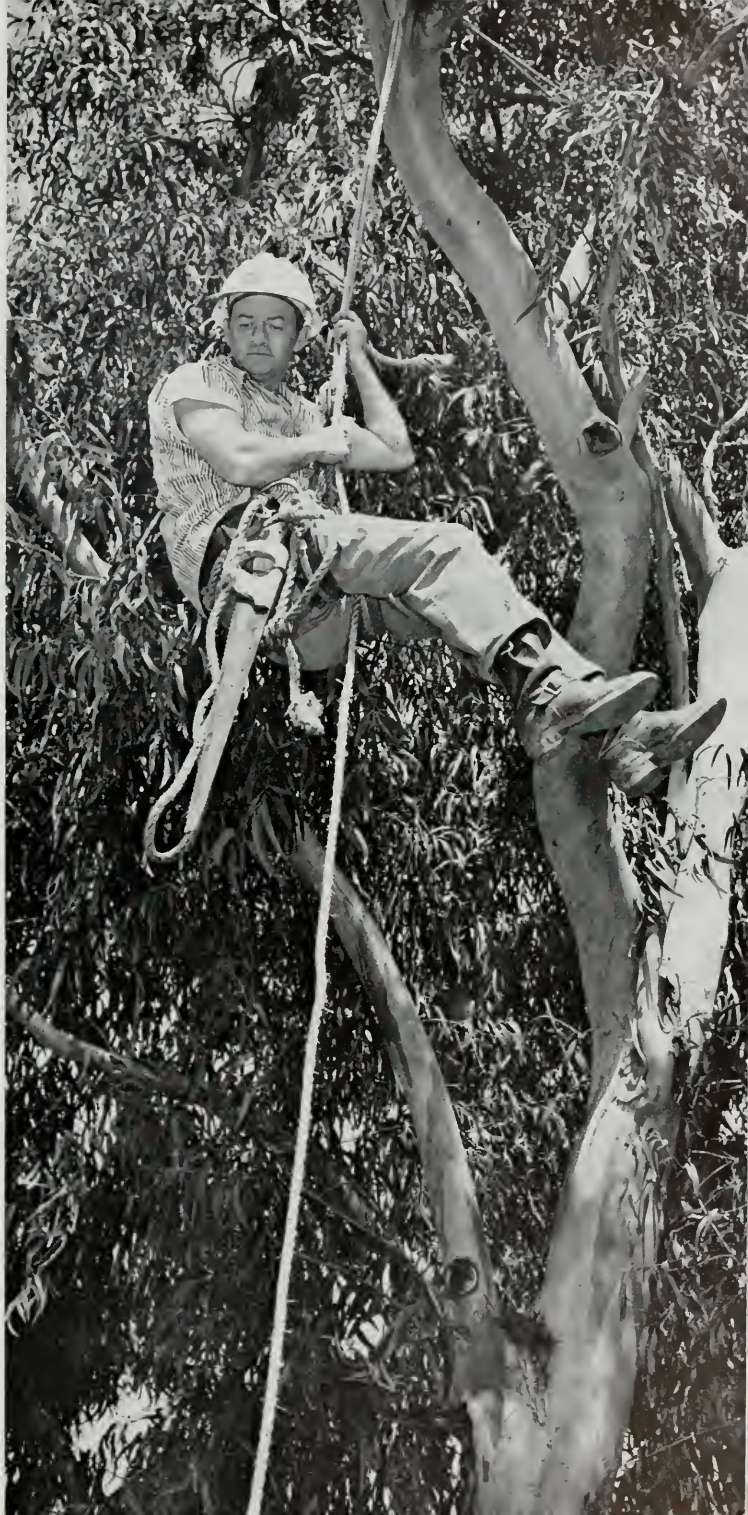
● **Delineation:** Trees are planted to mark structures which might not otherwise be noted by a fast moving motorist. Shrubs or trees accentuate a curve, and a ground cover emphasizes a traffic island or "gore" between the main route and the off ramp. All these plantings mean additional maintenance.

● **Erosion control:** Wherever any of the slope stabilization methods are used, the plants must be fed, watered, and weeded for several years until they are established. Some must be watered indefinitely. The contractor's responsibility for plant establishment on landscaping contracts usually ends after 90 days.

● **Fire control:** Because of careless smokers, "fire control" is necessary on thousands of miles of state highway, to protect such flammable areas as forest, grassland, and grainfields. This is another problem which does not trouble states with adequate year-around rainfall.

In most of California's rural areas today, fire control simply means removal of all vegetation from a four-foot strip outside the shoulder on either side of the road. Sometimes this is accomplished by discing or grading, but it is most likely to be done by chemical weed killers and sterilants. The sterilants are faster, neater, and leave no blackened roadside. Thirty years ago fire control was accomplished by spraying diesel oil on the roadsides; then, a week or two later, burning a ten-foot strip beyond the shoulder. Today's four-foot strip has proved adequate, and presents little bare area for soil erosion to start.

Where they can be used, evergreen ground covers are excellent fire controls. Unfortunately, because of the summer drought, it is impracticable to attempt to grow ground covers along highways throughout most of the state, since there are no satisfactory



RUFUS J. W. COX demonstrates safety line technique tought Division of Highways tree maintenance crews.



Section of U.S. 40 (Interstate 80) in the Sierra Nevada showing dike and cleared area outside it. Dike is essentially for control of runoff water, but also catches many cigarette butts.



Neatly trimmed section of U.S. 40 near Roseville blends into surrounding landscape.



Dense growth of drought resistant plants on U.S. 101 in San Luis Obispo serves to delineate turnoffs, to lessen fire hazard, to keep down weeds, to screen and to beautify.

ground covers which can survive any length of time without water. The mesembryanthemums, or ice plants, have proved practical in certain cool coastal sections where fog is common. Where conditions are good for them, they are almost ideal plants for slope control, fire control, and pleasant effect. Certain ivies are also effective, but they must have sprinkler systems installed for their survival.

All ground covers need some maintenance. The ice plant needs the least, but occasionally should be fertilized, and must be weeded assiduously until it is established (as must all plantings).

● **Roadside growth:** In recognition of the farmer's troubles with noxious weeds, the State Department of Agriculture has long been empowered to organize control methods to keep these expensive pests in check. There are several dozen species of weeds on the state's list which are potentially dangerous. By decision of the County Agricultural Commissioner, any of them can be declared a noxious weed in any county.

The Division of Highways cooperates on county programs, for noxious weed control. In most cases, where the infestation is serious, payment is made from highway funds to the county, to pay the expense of using specialists to control the pest on State highways. These payments amount to about $100,000 per year statewide. Where infestation is light, Division of Highways maintenance crews do routine weed control, most of it by mowing.

Whenever possible, weeds on the roadside are mowed early, before weeds go to seed, which gradually tends to reduce roadside growth to grasses only. Several more mowings are made during the season as necessary. Mowing reduces fire danger, and also makes a neater roadside. Roadside mowing costs have been significantly reduced in recent years, by the adoption of the modern rotary type mower.

Roadside brush, which would otherwise gradually encroach on the roadway, particularly in foothill and mountain areas, must be kept in check. Brushcutters which cut a swath from the roadside and chippers, ingesting



Where medians are wide and midday traffic is not too heavy, power equipment can be used for maintenance. John Musitelli trims median on El Camino Real south of San Francisco.

the cuttings and returning them to the roadside as finely chopped twigs and leaves, are very effective, but somewhat slow and expensive to operate. Chemicals are widely used today for brush control.

● **Roadside tree maintenance:** The California Division of Highways has tree maintenance crews throughout the state. These men are in a special group which includes such job classifications as Tree Maintenance Foreman, Tree Surgeon, and Tree Trimmer.

The thousands of miles of roadside in the state highway system have many old plantings of trees which must be maintained. Modern planting practice also calls for generous use of trees for delineation at ramps and bridges.

Dead limbs and unstable trees that are a hazard must be removed; so must low branches which obstruct vision and roadway clearances. Trees which are too high must be topped lest they blow over in a high wind. When the scope of any of these jobs is too great for routine maintenance, they can be let out to contract by professional tree care companies.

● **General planting maintenance:** Modern highway practice in California calls for roadside beautification wherever possible in densely settled areas. This may be accomplished to a limited extent with functional planting, or where suitable billboard control laws have been passed, by a full landscaping project. In either case, the planting will not only be roadside beautification, but will also function to absorb highway noises, gases and dust, prevent fire, delineate traffic changes and control erosion.

Landscaped roadsides must be maintained indefinitely. This kind of maintenance includes pruning, weed and pest control, fertilizing, and irrigating. Pruning is relatively light, usually necessary only when a change in conditions requires it, such as disease, dieback, or occasional unexpected growth to a size where foliage interferes with sight distances.

Weed control is very difficult on new jobs, but gradually lessens as the planted shrubs and ground covers take over. Weed killer sprays and oil sprays are used considerably to protect young shrubs and young trees. Because of the weed problem, highway landscape architects today especially favor shrubs which branch out right at the ground and grow in a dense globular shape, such as Lehman eucalyptus, dwarf blue eucalyptus, and oleander. This kind of plant is

ideal for screens, but unfortunately plants of this habit are not available for all of California's soils and climates.

Watering from a tank truck is expensive. This kind of watering is only done when sprinkler systems are impracticable. Usually, the tank truck is used only to water drought hardy plants the first couple of years they are in the ground, to give them a good start.

This kind of watering is also dangerous; several of the tank trucks have been badly damaged by out-of-control vehicles, but luckily none of the operators was injured seriously. (Landscape maintenance is a dangerous occupation. Workers are hit by flung beer cans and flying hub caps, catch poison oak, get bugs in eyes, are stung by bees, bitten by snakes and spiders, sometimes even by small rodents such as squirrels and muskrats. They also have their share of the more common industrial accidents.)

Where economically feasible, and generally on major freeway landscaping jobs, permanent sprinkling systems are installed. These not only irrigate, but also wash the foliage. The water costs are high, however, and limit this type of installation.

No way has yet been devised to eliminate what virtually amounts to hand labor in performing most of these chores of freeway landscaping maintenance. The many cuts and fills, with their steep slopes, the odd shaped pieces of land around interchanges, the difficulty of working close to heavy, fast-moving streams of traffic, all tend to limit the use of mechanized equipment for this work. Some of the new back-pack power units with cutter attachments are being looked at hopefully. However, over the years the most fruitful channels explored to help this problem have been experiment and search among the plants themselves.



In the course of regular operations, maintenance workers Johnnie Shephard, Robert Spencer, and Jack Warman, District IV, replace a plant which has died.

The Division of Highways landscape architects have learned that except where communities are willing to absorb part of the maintenance cost, landscaping today must be more and more restricted to certain tried and true "workhorse" shrubs, trees and ground covers, and that the thousands of varieties of beautiful but delicate ornamentals which quickly succumb at the slightest rough treatment must be avoided.

These "workhorse" plants are the ones which can exist with little or no water, ordinarily do not require fertilization, and are virtually pest-free, hardy, and adaptable. The list of such plants is short, but each year, out of the many tried, a few new ones for the list are proved.

Such limited plant choices have occasionally caused the Division of Highways to be criticized for "lack of imagination" in its use of plant materials, but the fact is the lack of variety springs from practical economic considerations, rather than lack of esthetic sensitivity.

The restriction of planting to these easily maintained plants, plus an energetic and conscientious educational program given the landscape workers by their supervisors, has paid off handsomely. Ten years ago, the table of organization called for one landscape laborer to maintain three acres of highway landscaping. Today he maintains seven acres.

● **The litterbug:** In urban areas, where there is a landscaped freeway, landscape maintenance men do considerable litter removal. Disposal cans are obviously impracticable on these highspeed, heavily traveled routes, although the heavy traffic generates tremendous amounts of litter. The difficulties of enforcing the anti-litterbug law are obvious. The litter cans the state now provides in rural areas are serviced by maintenance forces, and they are collecting great amounts of litter, but many motorists still refuse to use them. Conversely, where cans

While the watering basin around young plant is filling, Clyde Francis, Groundsman, District VII, cleans up weeds.



ire close to communities, local people often use them for disposing of household garbage!

An intensive public education campaign, backed up by firm enforcement when possible, has been going on for some time. It must be assumed that those who continue to strew our highways with litter are an irresponsible minority whom no campaign will reach. Better clean-up equipment may be invented, but because of the nature of the work, this seems unlikely in the near future. It begins to appear that we must resign ourselves either to a heavy annual bill for litter removal, or be willing to accept dirty, unkempt roadsides.

All these things, from the median screen to litter, are over and above the job and the costs of removing snow, of repairing pavements, of replacing guard rails and signs, and those other tasks normally associated with highway maintenance. Aside from these unavoidable costs, maintenance of just the roadsides and of the trees, shrubbery, and ground covers on the right-of-way, whether it is functional planting or landscaping, increases in cost each year and is now approaching $5,000,000 annually. In addition, there is an annual bill for State highway litter cleanup in this state of about $1,250,000.

There seems to be no hope these costs will ever be less. In fact, we must expect them to be much more if we but consider that our present traffic loads will be doubled in about 20 to 25 years. Nor can we even expect that these costs will increase in simple ratio to traffic increase. Roadside maintenance costs on multilane divided highways are much higher than older-type two-lane roads because of medians, the large areas required for interchanges, larger cuts and fills, more structures, heavier traffic use, and wider right-of-way.

Expenditures for maintenance and administration of the State Highway System are limited to the revenue derived from one cent per gallon of the tax on gasoline and diesel fuel. With necessary expenditures approaching the legal limit, any further increase in landscape maintenance costs, which already constitute an appreciable portion of the total maintenance budget, requires very careful control and exercise of judgment for installations involving continued or more costly maintenance.





Above: Newly landscaped interchange on the Golden State Freeway in Los Angeles showing redwood planting boxes surrounded by gravel over sterilized soil. Original cost is less, and maintenance is minimized on large areas by this type of planting. Below: Older planting of some type on San Bernardino Freeway illustrates how this kind of landscaping delineates and beautifies.

(The next and final roadsides article will be concerned with the plants and trees used by the California Division of Highways, and why they have been chosen.)

The State Department of Public Works has awarded a $739,000 contract for construction of five miles of two-lane highway on State Sign Route 53 between Harris Creek and Lower Lake in Lake County.

The California Highway Commission at its May meeting allocated $250,000 as the State's share of 15 traffic signal, highway lighting and channelization projects located throughout the State.

Flood Problems - 2

State Helps on Guadalupe, Walnut Creek Projects

This is the second part of an article which appeared in the March-April issue.

GUADALUPE RIVER CO-OPERATIVE DRAINAGE PROJECT

By P. B. JANSEN, Associate Highway Engineer



A MAJOR co-operative project involving drainage is exemplified by the co-operative agreement between the Division of Highways and the Santa Clara County Flood Control District, providing for improvement of the channel of the Guadalupe River in conjunction with the project for conversion and expansion to full freeway standards of the Bayshore Highway, U.S. 101 Bypass, northwesterly of San Jose.

The Bayshore Highway, where it crosses the flood plain of the Guadalupe, was originally constructed about 1937 as a four lane highway with a narrow dividing strip. It is currently being reconstructed as a six-lane, ultimate eight-lane, freeway with a full width median.

The small channel of the Guadalupe River in this area has been historically inadequate to handle the flows resulting from major storms, hence flooding of the surrounding land has frequently occurred. At the time of original highway construction it was therefore necessary to bridge three historic overflow channels of the Guadalupe as well as the main channel. This unsatisfactory solution was the only one possible at that time and the highway has since been subjected to a number of inundations.

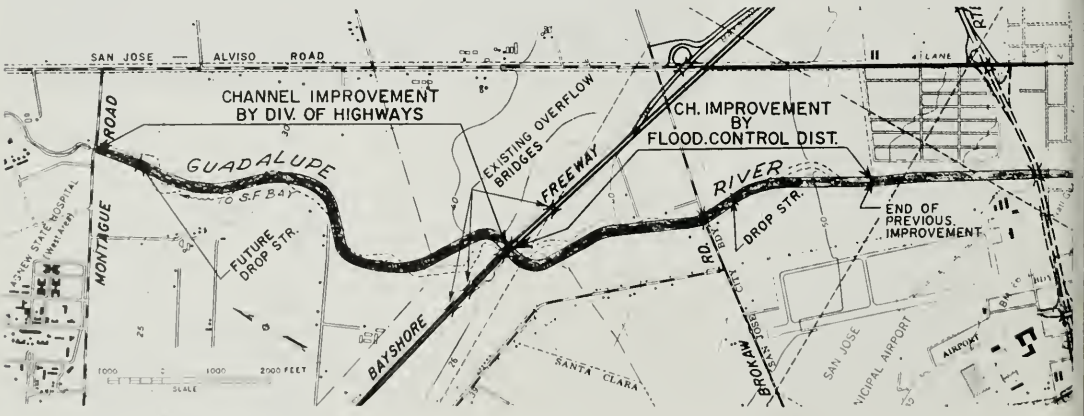
In planning the additional lanes of this highway facility it was recognized that unless channel improvement of the Guadalupe was undertaken prior to or concurrently with the highway project it would be mandatory to provide bridges for the additional lanes at the overflow channels as well as at the Guadalupe River.

Concurrent Studies

At the same time the City of San Jose and the Santa Clara County Flood Control District were conducting studies for channel improvement of the Guadalupe River, although it appeared unlikely that the flood control project could actually be undertaken until some time after completion of the freeway project. It was also realized that upon subsequent completion of the flood control project any money spent upon extension of the overflow bridges would have been wasted except for the relatively short period in which they would serve to retain the existing drainage conditions. It was further recognized that subsequent excavation of the channel improvement would yield large quantities of excess material which would probably present only a disposal problem, whereas integrated timing of the two projects would present an opportunity for economical use of the channel excavation in the highway embankment.

The reach of the Guadalupe influencing highway considerations extended from a point near Montague Road 8,000 feet north of the freeway crossing on the downstream side to a point 7,000 feet southeast of the freeway crossing on the upstream side. The latter point was the downstream terminus of a recent channel improvement project.

Had the necessary flood control works on the Guadalupe consisted of channel improvement only, no financial problem would have existed, since



A map of the Guadalupe River near San Jose showing the area improved by the drainage project discussed in the accompanying article.

the potential material from channel excavation could be economically utilized for the Bayshore Freeway and for the City of San Jose's Muncipal Airport, Guadalupe Parkway and De La Cruz Boulevard. The financial problem centered around acquisition of right of way for the channel improvement and the cost of expensive structures which were essential appurtenances to the channel improvement.

Channel Constriction

The existing bridge at Brokaw Road, which crosses the Guadalupe River about 4,000 feet upstream of the Bayshore Freeway, constituted a severe constriction in the channel and its replacement with one of adequate span comprised one necessary structure. Other necessary structures were imposed by the nature of the soil and the terrain. Although the terrain looks relatively flat, its general slope is steep enough so that if the improved channel were built on this slope, erosive velocities would be produced in the channel and through the Bayshore Freeway bridge.

The solution most adaptable to this difficulty was the employment of drop structures. A drop structure is a concrete structure incorporated into a channel, the essential feature of which is a vertical drop, thus permitting the reaches of channel upstream and downstream of the drop to be constructed on a gradient more gentle than that of the surrounding land. It was decided that the most favorable sites for drop structures were at a point about 700 feet upstream of Brokaw Road and at another point about 800 feet upstream of Montague Road.

Since properly timed construction of the improved river channel and its appurtenant structures would relieve the Division of Highways of the necessity of constructing bridges for the additional lanes at the three overflow channels, it was reasoned that the State could justifiably contribute toward the cost of the flood control structures an amount not to exceed the cost of these overflow structures. This amount was estimated at $150,000.

In accordance with the above considerations a co-operative agreement was negotiated between the Santa Clara County Flood Control District



The Guadalupe River channel looking downstream from the Brokaw Road Bridge.



A view of the improved Guadalupe River channel at Brokaw Road Bridge.



A view of the drop structure in the river channel north of Brokaw Road.

and the State which essentially provides:

1. The Flood Control District is responsible for construction of the channel improvement upstream of Bayshore Freeway, for the construction of the drop structures and the Brokaw Road Bridge, for the acquisition of all right of way necessary for the channel improvement and the operation and maintenance of the channel.
2. The State shall construct the channel improvement downstream of Bayshore Freeway, all excess material remaining after backfilling of the old channel and construction of levees to become the property of the State. The State shall contribute 50% of the cost of the two drop structures and 20% of the cost of the Brokaw Road Bridge, but not to exceed a total contribution of $150,000.

The Bayshore Freeway, the channel excavations, the Brokaw Road Bridge and the drop structure near Brokaw Road are nearly completed. Financial benefits to the parties to the agreement can be estimated from the bid prices for these units and from the preliminary cost estimate of the drop structure near Montague Road which is to be deferred until the time of channel construction downstream from that point.

Maximum Amount Required

Since the cost of the structures will apparently be such as to require the maximum contribution of $150,000 from the State, financial benefits to the State will accrue from the use of channel excavation material in the roadway embankments instead of the more expensive imported borrow, which would otherwise have been required. The total cost of the State's portion of channel excavation is $501,000; the value of the material to be used in the roadway embankment, figured at the cost of imported borrow, is $642,000, resulting in a net savings in construction cost of $141,000.

Financial benefits to the Flood Control District consists of the $150,000 contribution of the State toward the cost of the structures, and the value of State's work in channel excavation, $501,000 as noted above, for a total benefit of $651,000.

In addition to the direct financial benefits, this co-operative agreement has made possible the early completion of flood control facilities through a significant portion of the flood plain of the Guadalupe River. The consequent elimination of the flood threat makes possible accelerated development of the surrounding lands. Several years' potential flooding and closure of Bayshore Freeway and other facilities, with resultant public inconvenience, danger and economic loss, has also been eliminated.

WALNUT CREEK CO-OPERATIVE AGREEMENT

By A. S. LAGSDIN, Associate Highway Engineer

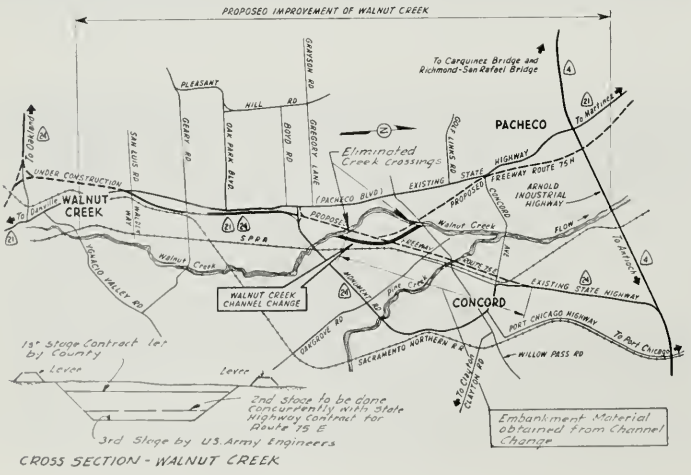
Scarcity of embankment material for the construction of the proposed freeway in the Concord area led to a co-operative agreement between the State and local agencies for realigning Walnut Creek in Contra Costa County. In addition to providing embankment material, one creek crossing will be eliminated and a total saving of approximately $667,000 to the State will be realized. If embankment material were not available in this vicinity costly borrow sites involving long haul distances would be the only solution.

Approximately 5700 feet of Walnut Creek channel will be realigned and the approximate 600,000 cubic yards of borrow when obtained will be placed as embankment in the highway right of way from 0.6 miles north of Monument Road to north of Concord Avenue.

Walnut Creek and its tributaries have a long history of hydraulic inadequacy and flooding of surrounding areas has been frequent. With rapid urbanization and industrialization of the watershed, the flooding problem has become more acute from year to year resulting in greater flood damage costs and increased danger to life and limb. These conditions have prompted the County to embark upon a crash program to improve reaches of Walnut Creek where the deficiencies are the greatest.

Creek Capacity Increased

This work extends from Arnold Industrial Highway up to Ygnacio



A map of the Walnut Creek area showing the channel change discussed in this article.



Looking south at the completed first stage of channel relocation which will serve for flows in excess of 7,000 cubic feet per second.

Valley Road and will increase the creek capacity from approximately 7000 cubic feet per second to 11,000 cfs. This work will offer a reasonable degree of protection to private properties and portions of State highways for floods approximately the 1955 and 1958 magnitude in the Walnut Creek watershed area.

All work being done will fit into the creek improvement program to be done by the United States Army Engineers and designed to handle 18,000 cfs in the channel change reach. This is the estimated required capacity after full development of the watershed. The Army Engineers' work will extend from Suisun Bay through all reaches of Walnut Creek and a short portion of the downstream reaches of the tributaries: Grayson, Las Trampas and San Ramon Creeks.

The channel change being done under a co-operative agreement fits into the County's $672,000 program for improving drainage and will result in an overall saving of taxpayers' monies to the State and the County.

Originally it was planned to construct the channel change on a State-let contract concurrently with construction of Route 75-E; however, the County program made it necessary to proceed with the channel change as soon as possible on a separate contract.

The State agreed to this arrangement; however, the project appeared doomed when it was learned that the East Bay Municipal Utility District could not relocate their aqueducts, which cross the channel change, last year. This obstacle, however, was overcome by a plan wherein an overflow channel 3 feet to 5 feet deep with an average bottom width of 240 feet would be constructed along the same alignment as the channel change and fit into the ultimate channel section. This channel would act as a bypass for the present Walnut Creek channel in this area for runoff quantities in excess of 7000 cfs and would cross over the East Bay Municipal Utility District's lines. The old creek and the bypass will handle a combined drainage quantity of 11,000 cfs.

County Lets Contract

This work was done on a contract let by the County to the Ransome Company for $76,000 paid by the State. Had the County improved the creek along the old alignment the cost would have been $90,000 to the County.

After the EBMUD lines are relocated, the next Walnut Creek channel change work will either be done concurrently with work on the freeway on a State contract or possibly as a separate contract let by the State. The old creek will be connected to the channel change with nominal size pipes upstream and downstream to preserve existing riparian rights.

The co-operative agreements between the State and the Contra Costa County agencies provide essentially that the State will provide all plans and specifications and construct the channel change placing the excavated material in the freeway embankment and bear all costs involved in engineering, construction and right of way acquisition.

The Flood Control District will accept and maintain the channel after its completion.

Substructure work on the Benicia-Martinez Bridge is about six weeks ahead of schedule and the superstructure contract is about on schedule.

PERSONNEL AIDES CONFER ON NEW PROCEDURES



The people in charge of processing the hundreds of thousands of personnel transactions it takes to operate a 14,000-employee organization met in Sacramento on April 6 and 7 for intensive study and discussion of current problems and procedures. The agenda for the personnel clerks, representing all 11 district offices and equipment shops plus several departments headquartered in Sacramento, ranged from compensable injury documents to the new employee appraisal and development program.

Shown at the head table (background of photo) are, left to right, Training Officer Richard T. Soderberg, Personnel Officer Marian Smith, and Supervising Clerk II Evelyn Zozzi. Several other members of the Headquarters Personnel Section are seated at the various tables along with the district, shop and department representatives.

Harbor Freeway Project Wins Bonneroo Award in Los Angeles

On April 19, 1961, 900 highway construction men assembled in the Palladium in Hollywood for the Tenth Annual Bonneroo, a program sponsored by District VII of the California Division of Highways to reward engineers and contractors for high quality workmanship. Frank B. Cressy, Assistant District Engineer, Construction, acted as Master of Ceremonies.

Robert B. Bradford, Director of the Department of Public Works, presented the "Topper" trophy to Ukropina, Polich, Kral and J. E. Haddock, Ltd. for having completed the best highway contract in District VII during 1960. The winning contract was a section of the Harbor Freeway between 0.5 mile south of 190th Street and 0.2 mile north of 124th Street. The winning project was completed on August 5, 1960.

Robert M. Innis, State Resident Engineer in charge of construction on the winning project, was presented a similar award. Certificates of Merit were presented to Henry Rollston and H. L. Benedict, the superintendents for the contractor. Similar certificates were presented to all subcontractors and State personnel who participated in the construction.

The additional winners for the ten best contracts completed in 1960, as announced Wednesday night at the Bonneroo, were:

No. 2.—Ventura and San Diego Freeways: Between Lankershim Boulevard and San Diego Freeway and Between 0.3 mile south of Mulholland Drive and Ventura Freeway. Peter Kiewit Sons' Company, Contractor; F. E. Sturgeon, Resident Engineer.

No. 3.—San Diego Freeway: Between Jefferson Boulevard and 0.3 mile north of Venice Boulevard. Guy F. Atkinson Company, Contractor; S. K. Hoppe, Resident Engineer.

No. 4.—Golden State and San Bernardino Freeways: Between Sixth Street 0.2 mile north of Mission Road and Between Macy Street and Eckett Street. Vinnell Co., Inc. and Vinnell Constructors, Contractor; J. D. Hetherington, Resident Engineer.

No. 5.—Ventura Freeway: Between 0.3 mile east of Encino Avenue and Kelvin Avenue. Oberg Construction Corp. and Oberg Brothers Construction Co., Contractor; K. P. Mock, Resident Engineer.

No. 6.—Arrow Highway: Between Glendora and San Dimas. Boddum Construction Co., Inc., Contractor; B. J. Steele, Resident Engineer.

No. 7.—Valley Boulevard: Between Lemoa Avenue in the City of Walnut and Nogales Street in the City of Industry. A-1 Paving Company, Contractor; H. T. Antes, Resident Engineer.

No. 8.—Riverside Freeway: Between 0.4 mile west of Route 2 and 0.1 mile east of Placentia Avenue. Ukropina-Polich-Kral, Contractors; P. Varvis, Resident Engineer.

No. 9.—Palmdale Boulevard: Between 10th Street East and 0.4 mile east of 20th Street East. Frederickson & Kasler, Contractor; T. W. Fera, Resident Engineer.

No. 10.—San Bernardino Freeway: Between 0.2 mile east of San Dimas Avenue and San Bernardino County Line. Matich Constructors and W. F. Maxwell Company, Contractors; R. E. DeGroff, Resident Engineer.

The contracts are rated primarily on the basis of workmanship and excellence on the various major items of work and smoothness of the finished pavement. Job complexity, safety and diligence of contract prosecution are also factors which are considered in judging the ten best projects.

Bridge Bonds Sold for Terminal Island Span

The California Toll Bridge Authority sold $5,000,000 in revenue bonds on April 11 to complete the financing for construction of a suspension bridge over the main channel of Los Angeles Harbor between San Pedro and Terminal Island.

The successful bidder was a group represented by the First Western Bank and Trust Company which offered to purchase the bonds at a net interest rate of 4.8743 per cent per annum. Expiration date of the bonds is July 1, 2000.

The bonds are expected to be delivered to the successful bidder within 30 days.

The only other bidder today was The First Boston Corporation which offered to buy the bonds at a net interest rate of 4.9999 per cent.

The $5,000,000 in revenue bonds will be added to money from other sources to finance the $21,000,000 San Pedro-Terminal Island project. A total of $12,400,000 in state highway funds is available for the project, plus $4,000,000 in state highway user taxes allocated to the City of Los Angeles and Los Angeles County.

The April 11 bid opening was the third time the Toll Bridge Authority had met to receive bids on bonds to help finance the San Pedro-Terminal Island project.

No bids were received last September when $7,000,000 in bonds were offered for sale. Last month the Authority rejected the only bid received on $5,000,000 in bonds because of a legal question concerning a possibility of a conflict of interest.

The Division of Highways in March received low bids totaling $14,008,040 for contracts to construct the bridge substructure and superstructure. Later contracts will provide for construction of roadway approaches and the installation of toll collection equipment.

The bridge will be Southern California's first state toll bridge. The suspension type structure with steel girder approach spans will be 6,010 feet long.

The bridge will have the third longest span in California, exceeded only by the Golden Gate and San Francisco-Oakland Bay Bridges. The main span will be 1,500 feet between towers, and each of the side spans will be 506 feet long.

The bridge towers will rise 370 feet above the water line. Vertical clearance for ships in the main channel will be 185 feet. The bridge deck will be 52 feet wide between curbs, providing four traffic lanes.

Plans call for the start of approach roadway and toll plaza construction next fall, with the entire project due for completion late in 1963.

The bridge will be located near the west end of Terminal Island, slightly north of the present route of the Terminal Island Ferry which it will replace.

On the San Pedro side the approach will extend to Pacific Avenue near Amar Street, crossing over and connecting with Harbor Boulevard near Regan Street.

On Terminal Island, where the toll plaza will be located, the project will end on the south side of Seaside Avenue near Mormon Street.

Commission Approves More F.A.S. Jobs

The California Highway Commission at its May meeting approved eight projects on Federal Aid Secondary County Roads with a total estimated cost of $1,130,000.

The projects approved were:

Lake County—Constructing a new bridge over Purah Creek on Big Canyon Road near Middletown.

Plumas County—Widening 2½ miles of the Bucks Lake Road in Quincy between U.S. 40 and 2½ miles west.

Plumas County—Surfacing of nine miles of Beckwourth-Calpine Road between the Sierra County line and U.S. 40 Alternate near Beckwourth.

Sierra County—Reconstruction of two miles of the Ridge Road between 11 and 9 miles west of Alleghany.

Napa County—Resurfacing sections of the Silverado Trail and Old Sonoma Road near Napa.

Santa Barbara—Widening of a section of Cathedral Oaks Road and construction of a bridge over Maria Ygnacia Creek west of Santa Barbara.

Tuolumne County—Reconstruction of ½ mile of the Tuolumne-Sonora Road east of Sonora. The project includes construction of a new reinforced concrete bridge over Turnback Creek.

Highway Employee Is Co-author of Book

A Division of Highways employee has entered the ranks of published book authors.

He is John Robinson, Associate Editor of *California Highways and Public Works*, whose book "State Parks of California", written with Alfred Calais, Information Officer for the State Division of Beaches and Parks, was published by *Sunset* magazine in April.

In addition to descriptions of each of the State's 170 odd parks and historical monuments, the book also has more than 170 photos, all taken by Robinson, whose articles and photos have previously appeared in many well-known magazines including *Sunset, Better Homes and Gardens, Family Circle, House Beautiful, American Home, House and Garden, This Week* and various newspaper supplements.

Robinson and Calais visited each of the parks to take the photos and get on-the-spot material for their descriptive write-ups.

Their book is published as one of the Sunset Travel Series.

Robinson joined the Division of Highways in 1957. A native of Farmingdale, New Jersey, he served with the U.S. Navy from 1928 to 1948, including a two year tour of duty in Pago Pago, American Samoa from 1939 to 1941.

Following his retirement from the Navy, Robinson studied at the University of California at Berkeley and did free-lance writing and photography.

Robinson is also the author of the series of articles "California Roadsides" currently appearing in *California Highways and Public Works*.

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THEN!

This issue's "Then and Now" page departs from the usual commentary on our changing times, and depicts a piece of the rolling stock of the Division of Highways in the District VI parking lot as it looked before and after it made contact with another vehicle. Robert R. McDonnell of Porterville, Highway Engineering Associate, was proceeding south on U.S. 99 on state business when he saw a pickup coming toward him in his lane going the wrong direction. He made every effort to avoid collision, but could not. Driver of the pickup was killed. McDonnell was wearing his seat belt and was able to walk away from his wrecked car.

NOW!



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JULY-AUGUST 1961

State of California Department of Public Works DIVISION OF HIGHWAYS CIRCULAR LETTER NO. 61-158	File Classification: Planning - Advance Planning - No. 17
TO: All District Engineers and Headquarters Office Department Heads	Date Issued: June 15, 1961 Expires: June 15, 1966
SUBJECT: Cooperation of Division of Highways With Other Governmental Agencies	
References: None	

Increased emphasis is being given by the Governor's office to the necessity for cooperation between State agencies and for cooperation of State agencies with other governmental units at all levels of authority. In the field of highway transportation this policy points toward working with other agencies and coordinating our planning and operations functions with them to the maximum extent possible. A constant attitude of cooperation and an appreciation of the diverse objectives of these agencies as important and vital factors in the public interest and economy of the State should be maintained at all times by Division personnel.

Recognizing that there is no provision of law at the present time which requires coordinated planning of various governmental agencies engaged in the field of transportation, the California Legislature, in a recent session, resolved as follows:

> "That all state and local governmental agencies having jurisdiction over the planning, development, construction, and operation of public transportation facilities including freeways, highways, toll bridges, roads, streets, vehicular parking, motor transit, rail transit, rail rapid transit, and such other public facilities as relate to the movement of people, are hereby urged to cooperate voluntarily in the joint exercise of their powers as is now permitted by law, in planning and developing public transportation facilities to the end that optimum safety, convenience, efficiency, and economy in the movement of people in metropolitan areas may be achieved; and be it further
>
> RESOLVED, that the Secretary of the Senate be directed to transmit copies of this resolution to all state and local governmental agencies having jurisdiction over the planning, development, construction, and operation of public transportation facilities including freeways, highways, toll bridges, roads, streets, vehicular parking, motor transit, rail transit, rail rapid transit, and such other public facilities as relate to the movement of people."

The Department of Public Works and the California Highway Commission subscribe to this legislative directive, copy of which is attached for reference purposes.

The outstanding results of the recent 210, SCR 26 and SCR 62 studies and many other cooperative ventures with governmental units point to the value to the Division of Highways of coordinated effort with other agencies of the State.

Accordingly, I desire that the heads of departments fully apprise their personnel of this philosophy and exercise cooperation and coordination of effort with other agencies within the limitations imposed by the law and wherever it will serve the public interest.

J. C. WOMACK
State Highway Engineer

California Highways and Public Works

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FRONT COVER—Members of the paint crew work on one of the main cables of the San Francisco-Oakland Bay Bridge high above the City of San Francisco. (See "Painting the Bridge," beginning on page 5.)
—Photo by Bob Dunn

BACK COVER—The new section of freeway on U.S. 101 through the City of Pismo Beach parallels the old highway. The broad street farther right is Sign Route 1. The City of Arroyo Grande is in the right background. (See "Pismo Beach," beginning on page 2.)
—Photo by William R. Chaney



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CALIFORNIA HIGHWAYS AND PUBLIC WORKS
P. O. Box 1499
SACRAMENTO, CALIFORNIA

Pismo Beach

Last City Street Section on U.S. 101 In San Luis Obispo County Eliminated

By ROY ALDERMAN, District Construction Engineer



THE MAY completion of the 2½ mile Pismo Beach Freeway has eliminated the last section of city street routing for Highway 101 in San Luis Obispo County. Completion of this project brings the freeway and expressway mileage in San Luis Obispo County to a total of nearly 70 miles. This leaves less than three miles of U.S. 101 in San Luis Obispo County as undivided highway, and even this minor mileage will be eliminated in the near future.

Pismo Beach is an important recreational area with its fine beach, mild climate and excellent clamming and fishing. There is evidence that these factors have attracted tourists to this area for at least 3,000 years. Indian artifacts found in the Contractor's privately owned borrow site were examined by archaeologists from the Division of Beaches and Parks. It was the archaeologists' opinion that the artifacts were 3,000 to 4,000 years old. It was also their opinion that these Indians were not native to this area but were tourists from Arizona. From the number of clam shells associated with the artifacts, the Indians were obviously attracted by the easy living. This tourist attraction in modern times has resulted in an extremely heavy annual increase in tourists and summer residents.

Old Highway Undivided

The existing facility through Pismo Beach was a four-lane, undivided highway with parking on both sides of the roadway and numerous cross streets. The high volume of both local and through traffic with the attendant turning movements and cross traffic created an intolerable traffic situation and was the cause of numerous accidents. The frustration and congestion thus created has been eliminated by the completion of this project.

Alternate locations for this freeway were severely restricted by the terrain. Pismo Beach is situated on a narrow shelf between the Pacific Ocean and the Santa Lucia Mountains. The Santa Lucia Mountains in this area are very steep and rugged and construction of a highway through the mountainous section would have been prohibitive. The location selected for the new freeway was parallel to and approximately 200 feet east of the existing route.

> *Mr. A. M. Nash, District Engineer*
> *Division of Highways*
> *San Luis Obispo, California*
>
> Dear Mr. Nash: At the regular meeting of the City Council of the City of Pismo Beach, held May 1, 1961, the Council voted unanimously to write a letter to the Division of Highways commending your Resident Engineer on Pismo Freeway Construction, Mr. L. D. Kraatz, on the manner in which he handled different mattters that came up during construction, for his help and cooperation with the city, and his attendance at Council meetings, with answers to problems before the Council, at any time he was requested to do so.
>
> It has been a pleasure, to the Council and city personnel, to work with Mr. Kraatz.
>
> Very truly yours,
> CITY OF PISMO BEACH
> Elizabeth Jatta
> *City Clerk*

The new facility is a conventional four-lane freeway and connects a freeway section constructed south of Pismo Beach in 1956 to an existing expressway north of Pismo Beach built in 1949. Four new lanes were constructed. The left lane of the existing expressway section at the north end of the city was converted to a combination of frontage road and connection for State Sign Route 1. This frontage road was connected to an existing frontage road which serves the neighboring community of Shell Beach. Local traffic can travel between Shell Beach and Pismo Beach, a distance of approximately one mile, without entering the freeway. This connection was made in the vicinity of the north Pismo Interchange and freeway traffic can leave the freeway here to travel to either community or to the many motels and restaurants served by the frontage road.

Other Interchanges

Other interchange facilities were constructed at Villa Creek, the southerly beginning of the project, Hinds Avenue and Wadsworth Avenue. At Villa Creek the freeway is carried over both the creek and a northbound off ramp by paralleling T-beam bridges, four spans each. A third bridge, also T-beam but with three spans, carries the northbound off ramp over Villa Creek and crosses diagonally under two freeway structures. Hinds Avenue bridge is an overcrossing structure serving to connect Pismo Beach with Price Canyon County road leading inland to fertile agricultural valleys. Wadsworth Avenue traffic is carried by a pair of parallel T-beam bridges, each three spanned and 121 feet long. The north Pismo separation structures are also a pair of parallel T-beam bridges, each 123 feet in length and of three spans.

Pedestrian facilities are provided for on the Hinds Avenue overcrossing, also a pedestrian undercrossing at Pismo Street and existing sidewalks at Wadsworth Avenue, all to accommodate persons going to and from the

beach recreational area and to serve local needs.

The freeway itself was a standard PCC pavement construction except for the addition of two feet of Type A imported borrow under the standard PCC structural section. This additional structural thickness was made necessary by the highly expansive soils encountered throughout most of the project. At the extreme north end of the project, the materials encountered changed from the expansive adobe to massive shales and rhyolite. The rhyolite was mostly weathered or altered and blasting was necessary on only a small portion of the core.



The new freeway during construction through Pismo Beach. The view is northward, showing Shell Beach (left background). Bridges under construction in the foreground are over Villa Creek.

Drainage is Normal

Drainage on this project was fairly routine and consisted primarily of the normal drainage facilities. There was a minor channel change at Villa Creek where the channel was narrowed to reduce the span of bridges. To protect the channel, air-blown mortar was placed on the side slopes and broken concrete was placed on the channel bottom. All of the city streets cut by the new facility carried water toward the ocean and cross pipes were required. At two of these streets back water could not be tolerated, and it was necessary to provide a battery of pipes even though hydraulically one pipe would have been sufficient.

Bello Street, which parallels the freeway to the east, was completely rebuilt between Hinds Avenue and Bay Street, since it was required to serve as a collector and feeder street for the freeway. The portion of the existing expressway lane which is to function as Sign Route 1 was improved by strengthening the shoulder and placing a thin blanket over the traveled way.

Settlement platforms were placed in the approach fills where material overloads and a settlement period were specified. Additional settlement platforms were placed under the Wadsworth Avenue undercrossing fills. While no settlement was anticipated at Wadsworth Avenue, the settlement platforms were placed to provide the District with information should any settlement occur in the future. At the request of the Materials and Research Department, "Botts Dots" (reflective pavement markers) were placed as center stripe on the new concrete to evaluate this type of marking under coastal weather conditions.

This project was constructed by the A. Madonna Construction Company at a cost of $1,500,000.00. Construction began just after Christmas 1959 and completed in April of this year.

The work was under the supervision of A. M. Nash, District Engineer, L. D. Kraatz, Resident Engineer, with Jack Norberg representing the Bridge Department.



A southward view of the Pismo Beach Freeway under canstruction with traffic still using the old highway which porallels the sauthbound freeway lanes.



A southward view of Pismo Beach prior to construction of the freewoy showing the old U.S. 101 highway (center) and Sign Route 1 (right).

Painting the Bridge-1

Painted Surface Totals 370 Acres

By D. EWING MARSH, Maintenance Superintendent,
San Francisco-Oakland Bay Bridge



Construction of the San Francisco-Oakland Bay Bridge was begun July 4, 1933. The bridge was completed and opened to motor vehicle traffic at noon on November 12, 1936. Interurban train operation commenced on January 15, 1939, and was discontinued April 20, 1958.

The steel structure is 4½ miles long, runs generally east and west, and extends from about six feet above high water to 530 feet above high water at the airway beacons on top of the suspension bridge towers. The entire West Bay section is above elevation 150 feet, except for the suspension bridge towers below the roadway. On the East Bay section of the bridge, the structure runs from elevation 390 at the tower tops down to a minimum of between six to eight feet at the east end of the bridge.

Painting the aluminum finish coat on the upper chord eye bars on the East Bay cantilever structure. Treasure Island Naval Station is in the background.

On most steel towers the lowest elevation of steel is on top of a concrete pedestal approximately 40 feet above high water. There are about 146,000 tons of steel which are painted for protection. This tonnage has about 370 acres of painted surface. 105,000 gallons of paint were required for the original paint job which was applied as three coats of red lead and a finish coat of aluminum.

Original Treatment

Original specifications called for the steel to be sandblasted after arrival in the San Francisco Bay Area and painted with two coats of red lead paint prior to erection. After erection there was a third coat of lead paint and a spot coat of lead paint on rivet heads, seams, and edges, followed by a finish coat of black. Sandblasting and priming were done at three locations. About 50 percent of the steel was sandblasted at Bethlehem Steel Company, Alameda yard, with either sand or steel grit. The suspension bridge trusses were sandblasted and painted at Harbor Pier 92, San Francisco. There was a third steel yard adjacent to the Oakland Mole at Asia Wharf just south of the passenger train terminal there.

The first coat of paint was a 28 pound per gallon red lead with raw linseed oil which was very slow drying. To improve the drying qualities, the formula was changed by the addition of mineral spirits reducing the weight of paint to 27.9 pounds. The second coat paint was a similar red lead with the addition of lamp black for coloring. The original second coat weighed 24.7 pounds to the gallon, and when modified to improve the drying qualities, weighed 24.5 pounds per gallon. The third coat was also a red lead, carbon black, raw linseed oil paint, which weighed 22 pounds per gallon. Before the finish coat was



applied to the bridge, changes were made from black because of civic pressure, and aluminum was used for the finish coat. The aluminum originally used was a long oil varnish using tung oil. Two and one-quarter pounds of aluminum paste were used per gallon of varnish.

Paint Policy Established

Maintenance began before the bridge was opened to traffic as an Extra Work Order on a construction contract by painting a portion of the upper-deck floor system from the contractor's traveling gantry. These surfaces had been subject to motor vehicle exhaust during construction and were also contaminated by wind off the salt water at the lower or east end of the bridge.

Permanent maintenance crews were established in October, 1937, about a year after the bridge was opened to traffic. A small crew of ten men and a foreman were put to work at the lower end of the East Bay portion of the bridge.

Our program of steam cleaning to eliminate inter-coat contamination and minimize sandblasting and our policy of preventive maintenance were established at this time by the late Carl S. Hamilton.

Rust removal then was done by hand methods using wire brushes and scrapers. Some experimental work was done with electric motor-driven wire cup brushes, with little success. Maintenance painting at this time consisted of two lead spot coats and a spot coat of aluminum.

System is Changed

It was soon found that this was not practical, and the system was changed to be a first spot coat of lead, a second spot coat of lead, and a solid coat of aluminum. This also was found to be impractical because of the mottled appearance of the finish in a few weeks after completion. Another change was made, making the first coat of lead a spot coat, the second coat a solid coat, and the finish coat a solid coat of aluminum. This gave a good appearing finish to the structure, and the solid coat of lead immediately before the finish coat of aluminum has been continued since late in 1939.

Our present routine is as follows:

1. Steam clean all surfaces that can be reached and where it does not interfere with traffic.
2. Rust removal, that is, spot sandblasting, power brush buffing, hand cleaning, and phosphoric acid crack treatment and caulking where required.
3. First spot coat red lead on all seams, edges, rivet heads, and sandblasted areas.
4. Second spot coat red lead on all seams, edges, rivet heads, and sandblasted areas.
5. Third coat red lead, a solid coat.
6. Finish coat aluminum.

This treatment provides protection equal to the original paint job on all raw steel surfaces.

Surface Contaminants Studied

During these early days, some experimenting was done to determine the type of contaminants on the bridge steel. Distilled water wash samples were taken on areas of two square feet. The wash water was bottled and sent to the Division of High-

The first spot coat painting is applied an one of the towers of the East Bay cantilever section using air-powered hoists an trussed aluminum scaffolds designed by members of the Bay Bridge staff. The view is eastward with the Berkeley hills in the distance.



Painting the aluminum finish coat an top of the lateral bracing in the cantilever structure.



ways testing laboratory for analysis. A wind-powered air sampler was developed, which sucked the passing air in through a bottle of distilled water. These devices were mounted on the bridge, left for many months, and eventually the distilled water was sent to the laboratory for analysis. At this time there was a smelter on the San Francisco waterfront at the corner of Folsom and Spear Streets, only two blocks from the bridge, in a location where the prevailing winds blew the fumes across a portion of the bridge near Tower W-2. This smelter was removed during the war years.

Paint maintenance progressed westward from the east end of the bridge, the work being done principally on the lower-deck floor system until such time as scaffolding could be designed and installed for painting the upper-deck floor system. It was during this period that we learned from our distilled water samples that sea salt was to be found on the bridge surface as high as 400 feet above the water level. We also learned that on the upper-deck floor system (which is the bottom side of the upper deck, about 20 feet directly above the lower deck) we had heavy deposits from motor vehicle exhaust, soot, sulphurous acid deposits, and a certain amount of white formation which we believed to be aluminum hydroxide. It was after receiving these reports that we first decided to experiment with steam cleaning the bridge surfaces prior to painting. A used garage-type steam cleaner was purchased, adapted to portable use behind a tank truck, and thus began our program of steam cleaning which is continued to this day, although with improved equipment.

Dirty or old aluminum painted surfaces hold moisture, and in shady or poorly ventilated locations, the surface remains tacky or sticky to the touch until nearly noon. This condition is eliminated on steam cleaned surfaces, and they then become dry enough for painting at the regular starting time. We feel that by steam cleaning we gain a great deal by removing dirt, salt, acid, decomposed paint, and other contaminants, thereby providing a clean surface over which to paint, with better bond between coats and reduced inter-coat contamination.



The main cable scaffold runs on grooved wheels on handrail ropes. The deck is adjustable to keep it level. The wind curtains are rolled up, exposing the two working levels.

Size of Crews

The make-up of the paint crew through the years has been from the original 10 men in October, 1937, as follows: Late in 1938, separate crews were organized for the sections of the bridge east and west of Yerba Buena Island. The crew was gradually increased to 40 men by December, 1941, when the war started. During the war period, our crew dwindled from 40 men to 14 men at the Bay Bridge (and from 8 men to 2 men at the Carquinez Bridge). After the surrender, the Bay Bridge crew was built up to 50 men, at which time the Korean incident developed, and it dropped back again to between 35 and 40 men. Since the settlement of the Korean incident, we have attempted to limit the Bay Bridge paint crew to: 2 foremen, 6 leadmen, 60 painters, 2 laborers and 4 truck drivers. In our current budget, 1960-61, we have provided for 66 painters, which figure was also in the last previous budget, although we were unable to employ that many men because of our inability to recruit them.

Equipment and Tools

By December, 1938, we had developed three travelers (gantries riding

the lower-deck curbs) for reaching the bottom of the upper deck. We also had eliminated the wire rope catenary or springboard rigging used underneath the lower deck and, late in 1939, installed three large suspended scaffolds 6 feet wide and 85 feet long. By this early date it was well determined that ease of accessibility was of the utmost importance for painting a major bridge. Our records had indicated that the conventional methods of rigging require too high a percentage (20%-30%) of the painters' time. We consider this as lost time which could be more profitably used in cleaning or painting the surfaces. From as early as 1938, we have endeavored to have as large as possible scaffold units operating on wheels or on a track and with power drive whenever practical. In some locations rigging time has thus been reduced to only 5 percent of the total.

Tools used at first were found to be inadequate, and we began using compressed-air, power-driven, rotary wire brushes, both cup and wheel type. It was found that 3-inch wheel brushes and up to 3¾ inch diameter cup brushes could be operated successfully on straight buffers or grinders operating at free speeds of 7,000 rpm for cutting rust. It took a lot of trial and error to determine which commercial brushes would stand the abuse given them on this type of work. On broad flat surfaces, we used a 6-inch wire cup brush on a tool operating at approximately 2,400 rpm. These we called salt brushes and used them to remove the general accumulation of dirt and the white formation off the broad faces of floor beams and large steel members.

Many Techniques Developed

Many techniques were developed to fit local conditions, one of which was the use of bottle brushes or as the trade calls them, tube brushes, for painting long slots left in the steel because of erection clearances. One place where these occur is at the 2,400 floor beam connections where they attach to the trusses. To illustrate this, these floor beams are from six to seven feet deep with an open slot or hole approximately ½" x ¾" at each end between the connection angles. Many of these were swabbed with these long-handled bottle brushes. Some were plugged at the bottom and poured full of paint. Others were swabbed first and plugged at both ends. Many anchor bolt holes were cleaned and filled with mastic. Some of these anchor bolts were set in pipes 10 to 15 feet deep in the concrete piers. It was necessary to clean these out with air jets, after which they were either swabbed with red lead and filled with mastic or filled with red lead paint, depending on which was the most convenient at the time and at the location.

Among the other special tools and brushes used is what we call a crack brush or a grainer, which is a pure bristle paint brush, three inches wide, two inches long, and approximately ⅛ inch thick. The use of these enables us to paint in narrow slots and cracks with the best application of paint and without the destruction or severe abuse to the large brushes normally used by a bridge painter. There



A hoist behind the railing raises and lowers this suspender rope cage as much as 250 feet. Canvas curtains form a safety fence and protect passing cars from paint spatters.

are over 10,000 linear feet of one slot which is ¼ inch wide and ¾ inch deep.

Sealing of Cracks

During the first two or three years of bridge painting, the greater percentage of the time was spent on sealing cracks and seams at similar locations to those mentioned above. One inch round sash tools were bought without handles. Handles from 18 inches to 20 feet long are applied for reaching into inaccessible places. Every man on the job is furnished with a size 35 (4 inch) stucco brush, made to our own specification or to an acceptable high quality commercial specification, and a two-inch oval brush, also made to our specification. Seven and nine inch paint rollers with extension handles from 18 inches to 4 feet long are used and are very effective.

Caulking guns were a source of trouble until we abandoned the use of guns having a friction grip to force the piston and insisted on a gun with a ratchet level mechanism for forcing the piston. In addition to the wire cup and wheel brushes and hand scratch brushes, a variety of hand tools have been used for rust removal. We have used the usual hook scrapers, old file scrapers, stiff blade two-inch-wide putty knives, and wire flue brushes. Wire flue brushes have been used both in ¾-inch-round form and in a ¾-inch-square form. This latter is very handy when reaching between two angles, back to back, with lacing bars in between.

Sandblasting Begins

With the crew reduced to 14 men during the war years and after having used several thousand of wire brushes, we began experimenting with sandblasting. This was necessary for three reasons:

1. To speed up the work.
2. Because of the shortage of manpower, maintenance on portions of the bridge was getting ahead of us.
3. We had found that in the San Francisco Bay Area after rust becomes four to six years old it is very difficult to remove with hand or power-driven wire



The main tower scaffold, which is supported by 26 hoists, is articulated and completely encircles the tower. The scaffold works from 40 to nearly 500 feet above the water level.

brushes. At this age, the composition of the rust is such that wire brushes do not scratch it off, but wear it down to a smooth polish or glaze and leave the active tubercules imbedded in hidden pits. This condition is probably related to the water content of the rust flakes. Since 1946, practically all rust removal has been done by sandblasting until very late 1959 when some power brush use was resumed.

Electric Railway

During 1938, the interurban electric railway was being installed on the bridge. When this was finished, we were confronted with bare wires carrying 1,200 volts and suspended 12 inches beneath the upper-deck floor beams. At the completion of railway construction and just before the current was put into this catenary, a coat of lead paint and a coat of aluminum were applied to the soffits of the upper-deck floor beam lower flanges in this area, because it was felt it would be too dangerous to attempt to do it under railway operating conditions.

At one location on six or eight floor beams, the entire beams were painted in this manner over the railway area. The paint on the bridge was only about three years old at this time. Although these extra coats of paint were put on to delay breakdown as long as possible, their true value was not determined for many years. In some places these areas were 20 years old before we were able to repaint them, and by then the advantage of the extra paint was very noticeable. Parts of the bridge, 20 years old without repainting, were found to have a minimum of rust, possibly not over 5 percent of the area involved.

The operation of the bridge railway created its own peculiar conditions and problems. During this period, while we were confronted with working adjacent to both a 1,200-volt overhead catenary system and a 600-volt third rail, and except for minor touches and sparks made by tools, we were very fortunate in having no injuries therefrom. Where the trains



All surfaces that can be washed without serious inconvenience to traffic are steam-cleaned before repainting.

slowed down or applied their brakes, a condition of brake shoe scale developed. This scale or grindings from the brake shoes were leaf-like grindings or scales which were slightly magnetic and which stood on edge and stuck in the paint film. This was very difficult to remove.

During steam cleaning, various types of detergents and softening agents were tried, with little success. Our best efforts were obtained by increasing the amount of wetting agent in our own steam cleaning compound, and in some cases, the use of a special wetting agent in addition to the regular compound. In spite of these additives, it was still always necessary to scrub and scrape the heaviest deposits of brake shoe scale. These deposits would build up in the corners where they were trapped, and in some places were as much as ⅜ inch deep. This created a condition of stain when dampness caused the scale to rust and stain good paint, thereby causing us to remove paint which would not otherwise have required removal.

Local Conditions

Our experience has shown that we have many local conditions caused by (1) elevation of the bridge above the water, (2) position with respect to the prevailing wind, (3) accessibility for rain to wash the surfaces, and (4) rapid temperature change.

Portions of the bridge which have the minimum service life of paint are the upper-deck floor system, exposed to direct vehicle exhaust from the vehicles on the lower deck, the lower-deck floor system, where the vehicle exhaust billows around and is blown underneath, the north face of the north stringer, and the back and bottom of the north sidewalk. These surfaces are not washed by rain, and the surface contaminants hold moisture which absorbs more contaminants from the air and vehicle exhaust while the resulting solutions gradually become more concentrated and active.

Another local condition is in the first 500 feet west of Yerba Buena Island where the salt spray laden wind blows up the steep surface of the hill leaving a salt and moisture deposit which causes rapid breakdown in that area. Similar conditions exist at the east end of the bridge where the steel comes down to sea level. Other local conditions are created at the two curves in the bridge where there is a change of angle with respect to the prevailing wind which causes a high throw down of moisture.

This is the first of two articles on painting the San Francisco-Oakland Bay Bridge. The concluding part will appear in the September-October issue of the magazine.

GUTHRIE AWARDED DOCTORATE

James A. Guthrie of San Bernardino, member of the California Highway Commission since 1943 and currently its vice-chairman, was awarded an honorary degree of Doctor of Humane Letters in June by the University of Redlands.

The degree was in recognition of Guthrie's contribution to the State and his community, both as newspaper publisher and civic leader.

Sand Hills

Historic Dunes Section of U.S. 80 Being Reconstructed as Freeway

By J. DEKEMA, District Engineer, and ROGER F. KOCHER, Resident Engineer



The Sand Hills west of Yuma, Arizona, are a 6 to 8 mile width of blow sand dunes stretching from south of the Mexican Border to 45 miles north. Some of the dunes exceed 100 feet in height. Such large dunes move only several inches per year, while small dunes of several feet in height may move 50 feet per hour in high winds. Winds of 50 to 60 MPH are common during the spring, particularly during March and April. Inasmuch as a majority of the sand particles in the area are virtually the same size (0.1 to 0.2 mm.), are non-cohesive, and lack protective cover or shelter, constant shifting occurs. Considerable sand drifting will occur with winds of only 8 to 10 MPH. Winds of this speed are a daily occurrence during the construction period.

These dunes, in a barren, arid desert, have been a barrier to travel since 1540 when Melchior Diaz traveling up the east bank of the Colorado River crossed at Yuma to become the first European to set foot on California soil.

Wagon Trains Lost

Even the intrepid forty-niners passed around the Sand Hills, either overland through Mexico or by boat down the Colorado and the Gulf of California, then up the Pacific Coast. Attempts to cross the Sand Hills were all unsuccessful; legends exist regarding the loss of entire wagon trains in the moving, restless sand.

This article was presented as a paper at the 40th Annual Western Association of State Highway Officials Conference in Las Vegas, Nevada, in April, 1961.



This 1956 aerial of the dunes area shows U.S. 80 (thin line right) and the All American Canal (brood ribbon).



A remaining section of the improved plank road constructed by the California Highway Commission in 1916. It was built of eight-foot railroad ties placed side by side and secured with longitudinal iron bars.



A large dragline builds up an embankment on the U.S. 80 construction through the Sand Hills in 1925.



This 1925 photo shows a crew laying pavement on U.S. 80. The planks on the right laid crossways to support trucks carrying asphalt to the construction area.

In 1912, a group of San Diego businessmen, endeavoring to attract motorists from the East, built a crude but successful road across the Sand Hills. Thirty-six carloads of 12-inch planks were used. Two planks, laid parallel to each other and connected with cross boards, formed a section. Sections laid end to end constituted the road. When the traveler found his path blocked by drifting sand, he pulled sections from under their sand blanket and relaid the sections. The 60-mile trip from Yuma to El Centro generally required 12 grueling hours. A few traces of this road still exist as a remnant of the historical past.

In 1915, at a cost of $102,000, a highway bridge was constructed across the Colorado River at Yuma, greatly increasing automobile traffic, and making the recently built plank road obsolete as well as ending the days of the colorful ferry. In 1916 the California Highway Commission constructed an improved plank road across the Sand Hills. This timber ribbon was constructed of 8-foot long railroad ties. These ties were dipped in tar and laid solidly crosswise to the road. The ties were grouped in sections and held in place with longitudinal iron bars. A turnout, 8 feet extra width, was built each half mile. This road, a great portion of which is still visible, was too heavy to be moved easily and had to be periodically cleared by teams and scrapers. $35,000 annually was spent to keep this 7½ miles of roadway passable.

Asphalt Road Built

A 20-foot wide asphalt concrete road was built through the Sand Hills in 1925 and is in use at this time. The embankment was constructed with a dragline. Two 4-horse fresnoes were used to shape and level off the top of the grade and the slopes. Only the top three feet of the sand fill was watered and the trucks delivering asphalt concrete ran over planks laid on the sand subgrade. The asphalt concrete pavement on top of the sand has stood up well for more than 35 years, testifying once again that sand is a wonderful road-building material if it can be confined.

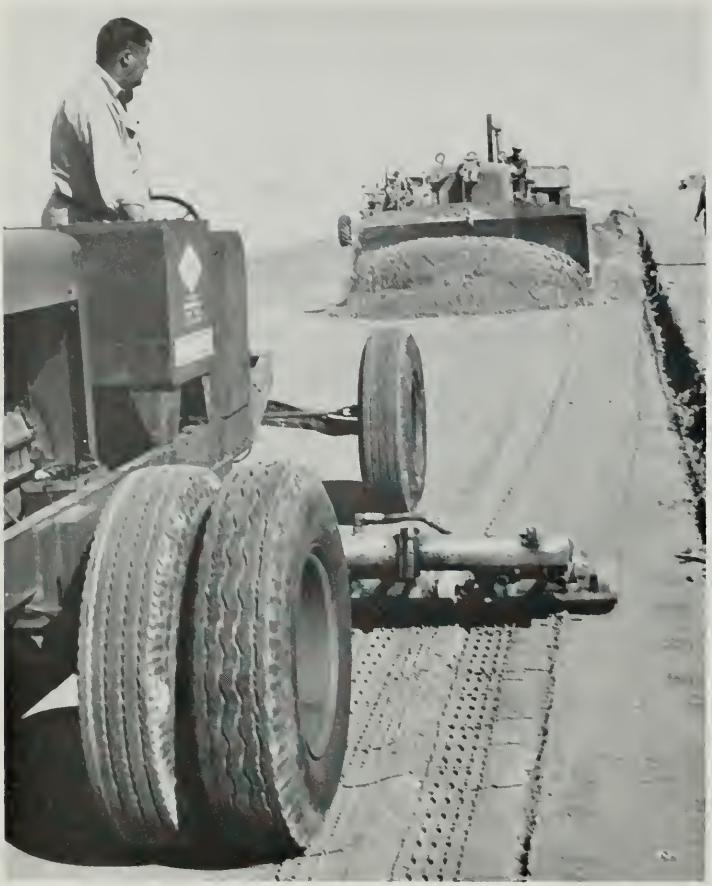
A duplicate crossing of the Sand Hills about 20 miles to the north was



A section of the improved plank road constructed by the California Highway Commission across the Sand Hills in 1916.



This photo was taken during construction of the 20-foot wide asphalt concrete road built in 1925.



Modern equipment in action on U.S. 80 reconstruction through the Sand Hills. A vibratory compactar is in the foreground. Beyond, a dozer spreads base material.

accomplished by the Imperial County Road Department in 1957-58. Under the direction of County Road Commissioner David Pierson, a sand fill was constructed entirely by bulldozers, pushing up about 1¾ million cubic yards of sand on 1¾:1 slopes. The top six feet were watered by a pipe line sprinkling system. The watering, together with the vibration from the bulldozers, gave 90% relative compaction.

Placement of the gravel base presented problems because trucks would sink into the sand. In order to permit trucks to use the subgrade, the County added a small amount of silt to the top six or eight inches. This was scarified in and laid down with a motor patrol and self-propelled rubber-tired roller. The structural section consisted of three inches road-mixed surfacing and four inches gravel base on the sand subbase. To date there is no sign of any trouble.

Slopes Sealed

In order to reduce wind erosion, the slopes were sealed with asphalt. It was essential that the slopes first be smooth because the wind would start undercutting at any opening and blow away the oil blanket. Smoothing was accomplished by tying a railroad rail between two tractors, one at the bottom of the fill, one at the top. The rail was then dragged back and forth, after which SC-3 was sprayed in two applications of 0.25 gal/sq yd each. A special angled spray bar was devised



This Division of Highways jeep is equipped with large tires for driving on the sand dunes.

because it was not practical to operate on the slopes.

Even today's low pressure tires will rut the sand subgrade on the current Interstate construction project and the contractor has had considerable difficulty preparing subgrade in advance of the crushed rock base to the close tolerances required by California's 1960 Standard Specifications.

Even after thorough compaction, the tires of the motor grader used to trim the grade, rutted the subgrade to depths of several tenths of a foot. Steel wheel and rubber-tired rollers buried themselves in the sand in attempting to prepare subgrade. A satisfactory subgrade was obtained by using a vibratory compactor as a finishing machine. By this means, subgrade was made within several hundredths of a foot of blue top stakes.

The base material must be placed upon the soft blow sand without contamination by the sand. Hauling vehicles and placing equipment could not be allowed upon the prepared subgrade. The base is placed in two 6" lifts. The first lift is started by backing the truck and end-dumping a load of base upon the subgrade. This pile is leveled and spread ahead with a "V" dozer. The next load and successive loads are placed by backing trucks over the previously placed base and end-dumping on the leveled base pad. This load is then spread ahead and the operation repeated.

Control of First Lift

Spread and thickness control of this first lift is achieved by placing 6" stake elevations on the subgrade just ahead of the spread. The lift is finally trimmed with a motor grader to close tolerance stakes.

The second lift is placed with a self-propelled aggregate spreader. After rolling, the finished surface is too rough and uneven for the base material to meet the thickness tolerance of 0.05'; therefore, the surface is staked with blue tops and trimmed with a motor grader and re-rolled.

The compacted sand subgrade, although non-cohesive, has a "Resistance" value of "70" when confined. A change order is therefore being processed to reduce the total base thickness to 8" placed in one lift.



An aerial photo of base-spreading operations during the current reconstruction of U.S. 80.



An aerial view of the haul road for construction equipment crossing the present highway.

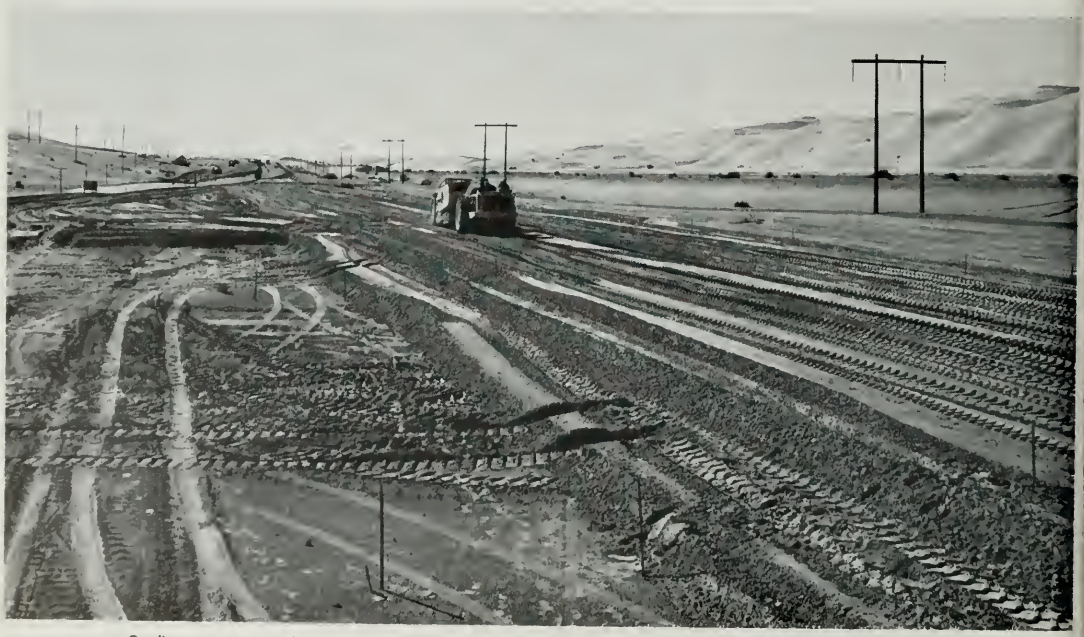


An aerial showing the location of the borrow pit in relation to the construction. A total of 2½ million cubic yards of borrow will be used in the completed embankment.

Trucks will break through a 4″ lift and a bulldozer only is used on end-dumped material. Segregation has been reduced by pushing piles of aggregate approximately 50 feet prior to actual laydown. Fairly successful attempts have been made to decrease segregation at the plant; however, it appears that dozer remixing on the street is necessary.

Finish grade staking required specially made stakes, 30″ long, diagonally cut 2 x 4's. Smaller stakes were found to be subject to movement. The contractor restricts his subgrade preparation to areas that can be covered by aggregate base within a day's time. Any subgrade left open to the elements—wind and sun—rapidly dries and erodes or is covered by drifting sand. Close coordination between the base and subgrading operations is necessary at all times.

Embankments are constructed of blow sand obtained from sites located approximately 1000 to 2000 feet south of the project. Average haul length is about 45 stations. A total of 2½ million cu. yds. of borrow is being



Grading operations on the current reconstruction of U.S. 80 through the Sand Hills. The present highway is on the left.



An aerial view of the All American Canal maintenance station and yard on the present highway which will be removed for construction of the new freeway.



A westward view of construction on U.S. 80 showing the bridge across the All American Canal. A second bridge is being built to the left of the existing one.

placed and paid for by the cubic yard in completed embankment.

70-Foot Fill

Since high sand dunes rise abruptly from the desert floor at the westerly end of the project, a very large volume of fill (635,000 cu. yds.) was required to construct a maximum allowable 3% grade at this location. This single fill rises 70 feet above the desert floor. Embankment slopes are 2:1 or flatter.

The contractor attempted to move rubber-tired scrapers into the borrow pit areas without success. The scrapers were virtually unable to move in dry sand and little more success was found even when the area was saturated with water. It appeared that track laying equipment, only, would negotiate this type of material. Various measures such as lowering scraper tire pressure and filling tires with water or water solutions aided movement, but it was still necessary to push the scrapers with track laying equipment from the pit to the fill.

The borrow haul problem was finally solved by using rubber-tired scrapers with power drive on front and rear axles. These units moved very well in the saturated sand. Incidentally, the engineer's special jeep with oversize tires could not operate uphill in the soft sand on the lee side of the dunes.

The contractor has constructed seven haul roads, totaling about 13,000 feet in length, between borrow pits and embankment areas. These haul roads, 30 to 40 feet in width and 4 to 6 inches thick, were built of about 8,000 tons of pit-run gravel. The total cost of these haul roads is estimated to be about $6,000. The proportionate cost per cubic yard hauled over such roads is negligible ($0.0025). The cost per load ($0.06) is minor.

It appears each scraper hauls approximately 8,000 sta. yds. per hour. Approximately 20,000 cu. yds. of embankment are placed daily by seven scrapers working seventeen hours.

Two Tractors Used

The scrapers are loaded by two push tractors, thus a total of 1,000 and more HP is used in loading. A typical

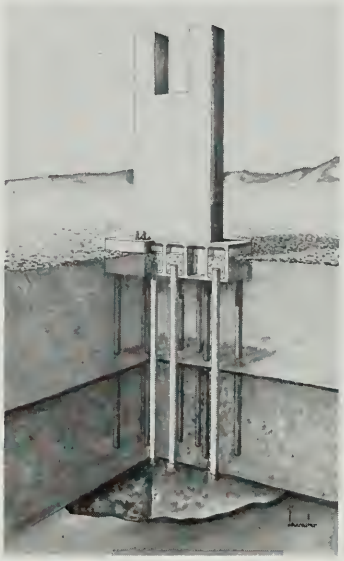
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Bridge Progress

Benicia-Martinez Job Completion Scheduled for Summer of 1962

By L. C. HOLLISTER, Bridge Engineer—Special Projects

Sometime in the summer of 1962 the fourth bridge across Carquinez Strait will have been completed and opened to traffic. Three of these bridges are highway structures and the fourth is a railroad bridge supporting two tracks of the Southern Pacific Company's main line.



This sketch shows how each pier was constructed. The 10 steel caissons were lowered to bedrock and sunk about two feet into it. Then an additional 5-foot socket was drilled into the rock, and the steel caissons and socket filled with concrete. The tops of the caissons were then anchored to the footing block by placing concrete in the cell around the caissons. From a theoretical standpoint, the 10 caissons of each pier were designed for earthquake by applying a theoretical horizontal load equal to 10 percent of the dead load of the superimposed trusses and the pier with the force located at the center of gravity of this dead load. The caissons were assumed fixed to the footing at the top and at a point about 30 feet above bedrock at the bottom of the caissan.

PHOTO BELOW—The empty celled concrete box footing was constructed on land, floated into place and then securely anchored in exact position ready to receive the first 6-foot in diameter, 130-foot long steel caisson.

The Carquinez Strait is a magnificent body of water and a great asset to the State of California. But in spite of its great commercial, recreational and aesthetic value, it has always been a troublesome problem to both highway and railroad transportation.

General Vallejo, with his great land holdings extending from Benecia to Santa Rosa, was the first to recognize that some type of highway transportation would have to be established across the Carquinez Strait if his great empire was to grow and prosper. Accordingly, in about 1848 he made efforts to establish a ferry across the Carquinez Strait between Benicia and Martinez. It was not until 1853, however, that a successful ferry was put in operation between these points. This was the start of the great ferry systems that were to serve the San Francisco Bay area for so many years, and in July 1962 the opening of the Benicia-Martinez Bridge will draw the final



curtain on this picturesque era that many will remember.

Structure is Planned

In spite of the success of these ferries, men were dreaming and scheming of some way to cross the Carquinez Strait with a structure. There was considerable skepticism however, as attested by the following quotation from the January 1899 issue of the Contra Costa *Gazette*:

> "The possibility and impracticality of a bridge across Carquinez Strait has been discussed for a long time both by the Railroad Company and by the leading Bridge companies in California.
> "A bridge between Port Costa and Benicia has also been considered. The prospect of a bridge between these two places is so absurd on the face of it that no engineer or company has ever surveyed or even advanced the proposition to the Railroad Company. I think that unless some wealthy lunatic of a company comes along and builds a bridge, that a bridge across Carquinez Straits will remain unbuilt till the end of time."

In spite of this rather typically dim view which was held by many, a three lane highway bridge was built across Carquinez Strait and opened to traffic in 1927 by the American Toll Bridge Company. Following the completion of this highway bridge, the Southern Pacific Company opened its bridge to railroad traffic in 1930.

Bridging the Carquinez Strait has not been easy, however, and the difficulty has been mostly in the foundation construction. Bedrock in the Carquinez Strait lies approximately 130 feet below the water surface. At this elevation bed rock consists of tipped up layers of shale and sand stone. Over the bed rock lies 50 to 90 feet of mud, sand and gravel. The problem has therefore been to penetrate this overburden through rather swift and changing currents of water and establish some type of pier foundations on the bed rock below.

First Pier Construction

On the first Carquinez Bridge, piers were constructed of two 40 foot square footing blocks topped by a 30 ft. diameter cylinder. Each of these casisssons was constructed of timber and held in position by a floating cage, which was in turn anchored in position. The caisson with its timber sides was sunk by adding concrete or weight on top and by excavating the material at the bottom, allowing it to gradually settle through the mud and gravel overburden until it came to rest on bed rock. The inside was then filled with concrete which became the foundations for the first Carquinez Strait bridge. The walls and excavating cells in the lower portion of these caissons were constructed of timber and after reaching bedrock the open cells were completely filled with concrete.

This was a slow, tedious and even hazardous process in the rather treacherous waters of Carquinez Strait.

The Southern Pacific Company chose to use a somewhat different and perhaps a much safer method of pier construction. At each of their piers a ring 80 feet in diameter of steel sheet piles was driven and the interior filled with sand to an elevation well above high water. On each of these "sand islands", as the method is called, the bottom portion of the concrete pier was constructed. Through dredging chambers constructed in each pier, the material from under would be excavated and pier allowed to sink. Adding concrete at the top and excavating at the bottom, the pier would finally be brought to bear on bedrock at the bottom. While this method was much less hazardous it was very costly.

Improved Method Used

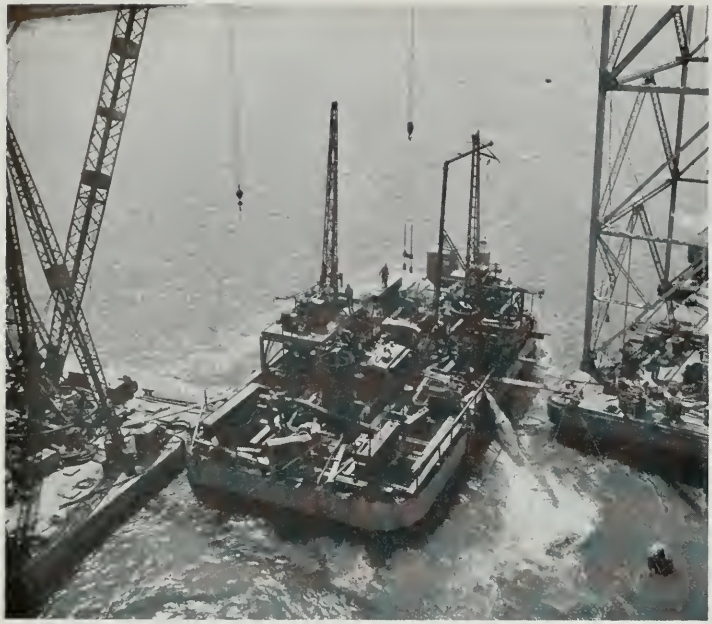
At the second parallel Carquinez Bridge (1955-58), an improved method was used which cost much less and still incorporates adequate safety features. This time the bottom 31 feet of the pier with its cutting edges was built in a dry dock and then floated into position where it was anchored. The concrete walls of the piers were then extended upward and as weight was added the pier sank through the water until it entered the mud line. At this point the timber bottoms to some of the 18 cells which had been constructed in the caisson would be removed and the mud excavated from under the caisson. Excavation and con-

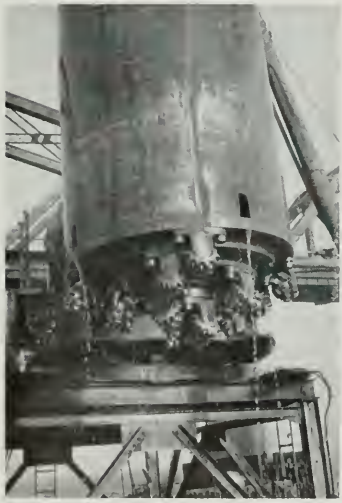






PHOTOS RIGHT—The 6-foot-diameter steel caissons were fabricated at the Benicia plant of the Yubo Consolidated Industries and floated to the pier site (top) where they were picked up by the "Judy Ann," a floating crane (center) and placed in one of the pier cells (bottom).





PHOTOS ABOVE AND LEFT—In these pictures the drill rig and oir lift pump ore at wark removing material from the inside of a caisson. The drill is made up of 12 gear like roller canes which cut into either the over burden or bedrack as they are rotated by the drill rig. Pressure an the rallers is adjusted as needed by adding or subtracting ballast in the steel shell which houses the rollers. An oir lift pump picks up the excavated material and discharges it into the bay.

creting would thus continue allowing the pier to sink until bedrock was reached.

Pier construction at the Benicia-Martinez Bridge was planned with an entirely new concept in mind, making use of new ideas, new equipment and new methods of construction. (See May-June, 1960, issue of *California Highways and Public Works*.)

The footing was so designed that it could be built on shore and floated into place, anchored in position, and then through predesigned openings in the bottom of the pier lower steel caissons each six feet in diameter. The mud, sand and gravel from the interior of these caissons was then drilled and pumped out until the steel cutting edge had penetrated into the bedrock about two feet. At this point a 5 ft. diameter socket was drilled an additional five feet into bedrock. A heavy reinforcing cage was then placed in the drilled rock socket and extended 13 feet up into the caisson. The socket in the rock and the caisson were then filled with concrete which anchored the concrete filled steel caisson securely into the bedrock.

Placing of Caissons

The four-corner caissons were the first to be placed while the box footing was still in a floating position. After the four corner caissons were concreted in and anchored to bedrock, then heavy steel beams with hangar rods would be placed over the four corner caissons at high tide. As the tide receded the beams would come to rest on the four caissons. At this point the box footing would change from a floating condition to a supported condition. Water was then pumped into other cells of the box footing in sufficient quantity to act as a ballast and prevent the box footing from raising off the four corner supports at the next high tide.

With the footing thus supported on the four corner piles, the remaining six caissons were installed and anchored to the bedrock at the bottom and to the box footing at the top. The support of the box footing was then transferred to these six caissons and the beams and hangar rods removed from the four-corner caissons. These caissons were then anchored to the footing by placing concrete in the cells. The footing at this stage became supported for the first time by all 10 caissons.

Construction from this point on was more conventional and consisted of placing the concrete slab over the top of the footing block and then extending up 90 to 130 ft. with a concrete shaft to form the seats for the steel trusses.

Rapid Construction

There are 9 of these piers and the average time to construct each one was about three months. This is a rather rapid rate for deep water pier construction and it is therefore believed that this method will have extensive applications in future deep water bridge construction where conditions are favorable or similar to those encountered at the Benicia-Martinez Bridge. Yuba Consolidated Industries, Inc., who are the contractors for both the substructure and superstructure have done an excellent job of sinking these caissons and should complete the foundation work about four months ahead of their contract time schedule.

The design and fabrication of the steel trusses like the design of the

foundations made use of new materials and new fabricating techniques. The Carquinez and the Benicia-Martinez Bridges are the first two major bridge structures to make use of new high strength steels and to use welding as a means of fabricating truss members.

The truss spans at Benicia-Martinez are 528 feet between supports. This span length is much smaller than the 1,100 foot span at Carquinez but nevertheless is sufficiently long to make any reduction in the weight or dead load pay excellent dividends. The use of a newly developed high strength steel in the trusses reduced the amount of steel required and thereby reduced the amount of weight to be supported by the trusses. In addition the truss members were fabricated by welding rather than by riveting which resulted in additional savings in weight. High strength bolts with gusset and splice plates were used at the joints to fasten together the welded members entering the joint.

Three Types of Steel Used

As was done in the design of the Carquinez Bridge, three types of steel were used in the makeup of truss members. Two grades of these steels carried the American Society of Testing Material's designation A7 and A373 for the usual structural grade and A242 for the higher strength low-alloy steel. The exceptionally high strength steel is referred to as T-1 by the manufacturer. The following table shows the comparative tensile strength of these steels:

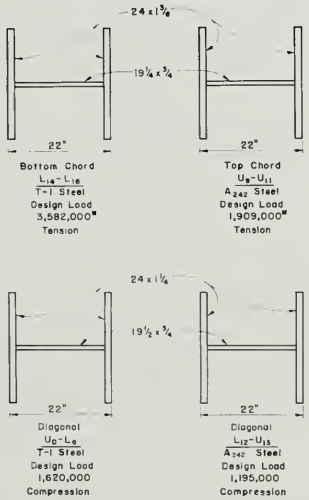
Type	Allowable Tensile Stress
A7 and A373	18,000 p.s.i.
A242—up to ¾" thick	24,000 p.s.i.
over 1½" thick	22,000 p.s.i.
T-1—all thicknesses	45,000 p.s.i.

The choice of steel for each member was based on maintaining minimum plate thicknesses. That is, T-1 steel was used until the minimum plate thickness requirements governed, then A242 steel was used. The same criteria governed the choice between A242 and A7. Unfortunately A242 steel loses efficiency in the thicker plates as can be seen from the above table of allowable tensile stresses.

Since all members were fabricated by welding, it was possible to provide



In this picture heavy steel beams are being placed over the four corner caissons. When these beams are in a predetermined position, the box footing is allowed to seat itself and hang from the beams as the tide goes out. At this point the footing changes from a floating to a supported condition and vertical or horizontal movement is no longer detected.



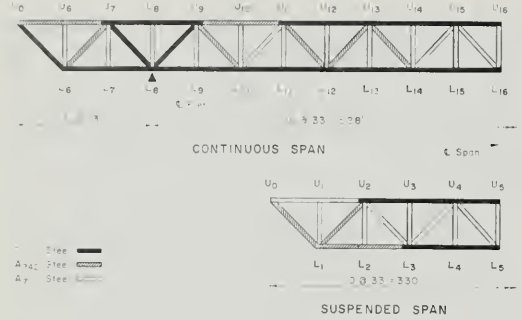
TYPICAL TRUSS MEMBER
MAKE-UP

This sketch illustrates how the truss members were fabricated by welding 3 plates together. The two top tensile members are the same size and weight yet the one fabricated from T-1 steel has almost twice the capacity of its A242 steel prototype, demanstroting how use of extra high strength steel saved a considerable tonnage of metal.

a very economical means of compensating for loss in net section caused by bolt holes at the joints. For instance in tension members fabricated from T-1 steel, the flange plates were increased in thickness at the joints for a distance one foot outside the gusset plate, at which point a butt weld was made. For tension members fabricated from A242 steel, the flange plates at the joints were made of the higher strength T-1 steel to compensate for the loss in section, and the two types of steel were butt welded together about one foot outside the joint. These new design procedures making use of welded truss members saved worthwhile amounts of steel in the tension members of the truss. Large amounts of steel were also saved by using extra high strength T-1 steel wherever practicable. For instance, it is estimated that 7,168,000 lbs. of T-1 steel in the trusses replaced 12,320,000 lbs. of A242 steel.

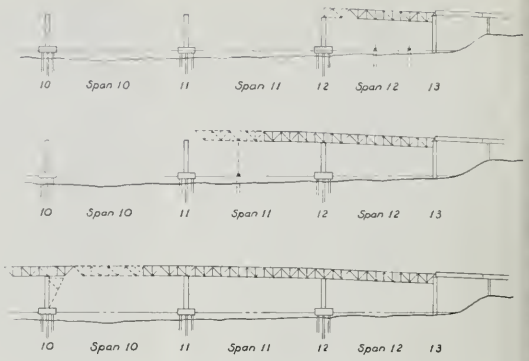
Price Difference Small

The three types of steel used carry different price tags but the differential price between the various grades of steel is sufficiently small to result in



BENICIA-MARTINEZ BRIDGE

Truss layout showing the location of the 3 types of steel used in the trusses. The 10 truss spans which measured 4,884 feet were designed for maximum duplication, there were 24 half suspended spans and 16 half continuous spans as shown above, making far considerable duplication in the fabricating shop.



Sketch Showing Truss Erection Procedure. Two temporary erection bents were used in the erection of Truss Span 12, the first to be erected. Truss Spans 3 to 9 inclusive will use one temporary bent and Truss Span 10 which is over the navigation channel will not use any of the temporary bents in the water but will use one inclined bent at Pier No. 10.



This sketch shows the relation of the new highway structure to the existing Southern Pacific Co. Bridge and the relative height of the highway deck above the water level. Maximum vertical clearance of the navigation channel between low steel and water is 138 feet on the highway bridge and 70 feet on the railroad bridge. The railroad bridge requires a vertical lift span for the passage of river traffic. Highway traffic will be about 178 feet above water at the highest point.



The highway bridge in the foreground commences to take shape. Nearly all of the piers are in place and ready to receive the steel trusses. Start of steel truss erection in Span No. 13 can be seen to the right.

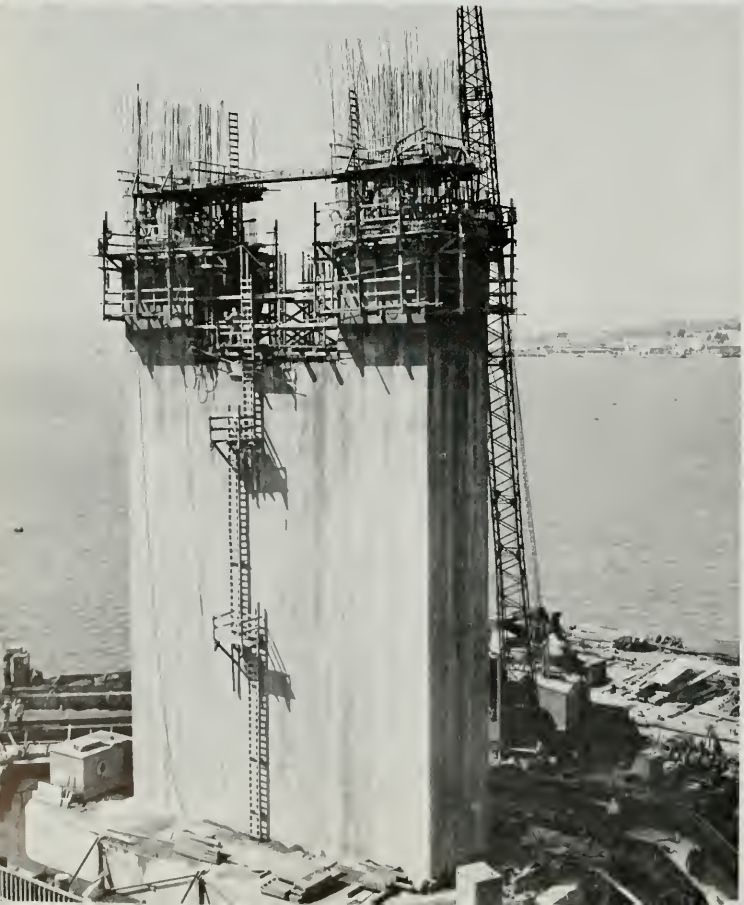


Steel erection on Span No. 12, the first truss span to be erected, is shown with the two temporary erection bents in place. One 4-panel section of the far truss remains to be lifted in place to complete the span.



This sketch shows the "Judy Ann", a heavy floating erection crane. This crane was used by the contractor to erect the Richmond-San Rafael Bridge. Safety nets are used to protect the ironworkers.





substantial cost savings by using the highest grade of steel practicable for the particular member in question.

The successful bid price per pound for the three grades of steel was as follows:

A7 and A373	18.57¢
A242	21.74¢
T-1	34.48¢

Erection of the steel trusses was started in May, 1961 and it is expected that the steel erection and concrete slab construction of the Superstructure should move along quite rapidly.

The truss erection method used by the Yuba Consolidated, Inc., makes use of temporary bents supported by steel H piles, as shown in the accompanying sketch of erection procedure.

Two of these bents were used in the erection of Span 13, the first truss span to be erected. Only one falsework or temporary bent will be used in each of the remaining spans.

Temporary Bent Omitted

Span 11 which is opposite the Southern Pacific Company's vertical lift span must be kept open at all times for river navigation. The temporary erection bent will therefore be omitted in this span and the truss will be erected by cantilevering out 13 panels from Pier 11 until it reaches the 4 panel section supported by an inclined temporary bent at Pier 10.

Where the cantilevered portion joins with the supported portion, the deflection will be as much as 8'-6" and the two sections will be brought together by using hangar rods and jacks. The remainder of the spans from Pier 10 will be erected in the same manner as Span 11 using one temporary bent.

The total project involves seven contracts as follows:

. . . Continued on page 30

PHOTOS LEFT—After completion of the box footing the cellular concrete stem of the pier, which rises about 100 to 130 feet above the footing, is started. The concrete stem is poured by the "slip form" method. The "slip form" method is a continuous 24 hour per day operation in which the form is jacked up at the rate of above 10 inches per hour. As the concrete at the bottom sets up and develops strength and hardness, the form is jacked free and the concrete stands exposed and unprotected. It required approximately 5 working days to pour each stem from the footing block at the bottom to the truss supporting surface at the top.

Vallejo Freeway

Latest Survey Shows Marked Decline in Accident Rate

By CHARLES A. PIVETTI, District Traffic Engineer



The problem of mounting traffic accidents is causing increasing concern throughout the nation. Consequently, any data indicating a trend towards reduction in accident frequency is welcome news.

Freeways save lives. This has been substantiated by reports from all over the United States indicating that freeways are from two to five times as safe as conventional streets and highways. Studies of accident records before and after conversion of city streets to full freeway show a trend in accident reduction ranging from around 7.5 to 1.5 accidents per million vehicle miles.

Statistics compiled for the California State rural highway network for the year 1959 show a statewide accident rate on highways other than freeways of 2.39 accidents per million vehicle miles whereas the rate on freeways was only 1.00 accident per million vehicle miles.

A review of accident records for that portion of U.S. 40 passing through the City of Vallejo offers substantial evidence that development to full freeway is the most positive and predictable approach to accident reduction that the highway engineer may employ.



BEFORE—This is a scene from the U.S. 40-Benicia Road intersection in Vallejo prior to construction of the freeway.



AFTER—An aerial of the State Route 74 Separation (foreground) and Benicia Road Overcrassing (background) following construction of the freeway.

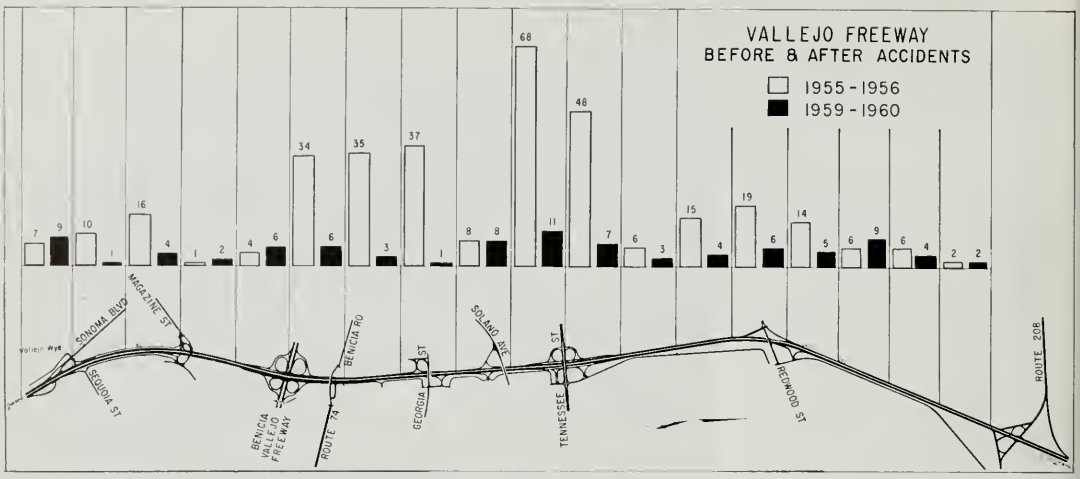
Accident Rate High

Prior to construction to full freeway, U.S. 40 through Vallejo had five of the most accident-prone intersections in District X. Despite constant attention and continuing attempts to reduce accidents through channelizing intersections and signalizing with expensive, interconnected signal systems, the 4.5 miles length of expressway with intersections at grade experienced 336 traffic accidents during 1955 and 1956. In these two years there were 99 accidents involving personal injuries and 4 accidents involving fatalities.

During 1957 and 1958 Vallejo's section of U.S. 40 was converted to full freeway.

The first two years of full freeway operation, 1959 and 1960, revealed a 73% reduction in accidents—*245 fewer accidents than during the two years preceding construction.* Of the freeway's total of only 91 accidents as compared to the expressway's 336, only 29 involved personal injury and only 2 involved fatalities.

The accompanying chart graphically illustrates the before and after picture for each quarter mile of the Vallejo Freeway. In addition to the observations by quarter-mile, the before and after study showed that replacing one intersection with a separated interchange reduced accidents from 34 in 1956 to 4 in 1959. At another intersection, replaced by an interchange, accidents were reduced from 16 in 1956 to 1 in 1959.





BEFORE—The intersection of U.S. 40 with Georgia Street in Vallejo prior to the building of the freeway.



AFTER—A view of the same section of U.S. 40 following completion of the freeway.

Four Increases Explained

Only four of the quarter-miles shown on the chart indicate increases in the actual number of accidents. One is a portion where prior operation simulated freeway operation since there were no grade crossings, and one contains the easterly approach to the Carquinez Bridge Toll Plaza. None of the four is particularly significant since the magnitudes are small, being in the order of 7 to 9, 4 to 6, etc.

Also, it should be pointed out that the reduction in number of accidents was concurrent with a substantial increase in traffic volume. The average daily traffic volume increased from 22,000 vehicles in 1956 to 29,000 vehicles in 1960. This means that the reduction in accidents per million vehicle miles is proportionately greater than the reduction in the actual number of accidents: the 1955-56 rate was 4.75 accidents per million vehicle miles, the 1959-60 rate was 1.07. This represents a reduction of 78% which indicates the freeway to be more than four times as safe as the expressway it replaced.

From these general observations of Vallejo Freeway accident experience, it appears quite obvious that this freeway has provided motorists with tremendously increased safety as well as savings in vehicle miles and operating minutes.

Corona Bypass

Riverside Freeway Now Continuous for 24 Miles

By W. H. CRAWFORD, District Construction Engineer

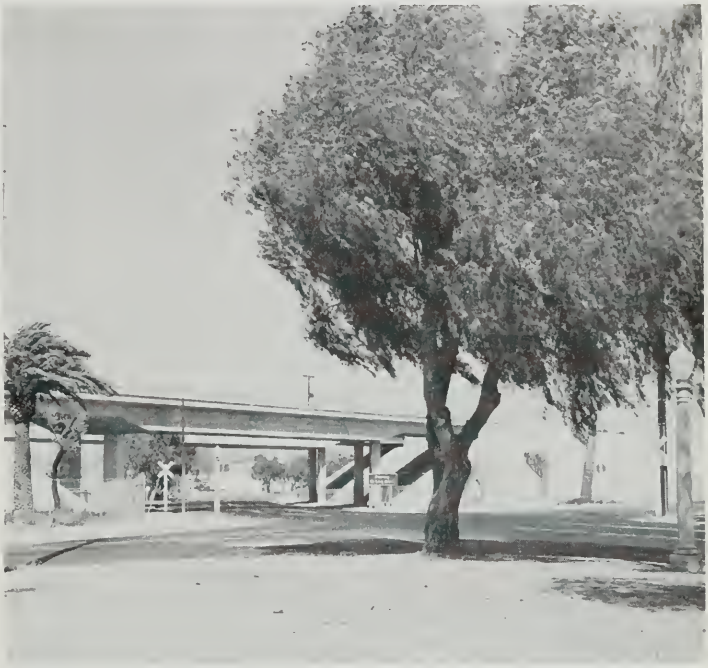


A $9 million, 7.7-mile section of the Riverside Freeway near Corona was opened to traffic April 6, 1961, in impressive ribbon-cutting ceremonies, attended by State and local dignitaries, on the deck of the Magnolia Avenue Overhead near the east end of the project.

The unit of freeway opened begins one-half mile west of Corona and ends at La Sierra, to the east.

Corona's Mayor A. J. Velthoen presented a certificate of appreciation to the construction firm of Fredericksen and Kasler, which built the freeway link. The mayor commended the firm for its work and attitude toward the public during the construction period.

Construction of the new freeway section began in January, 1960. It runs north of the former highway, State Sign Route 18 and U.S. 91. It passes west of the community of Home Gardens between Riverside and Corona, and runs north of the business district of Corona along what was formerly Second Street.

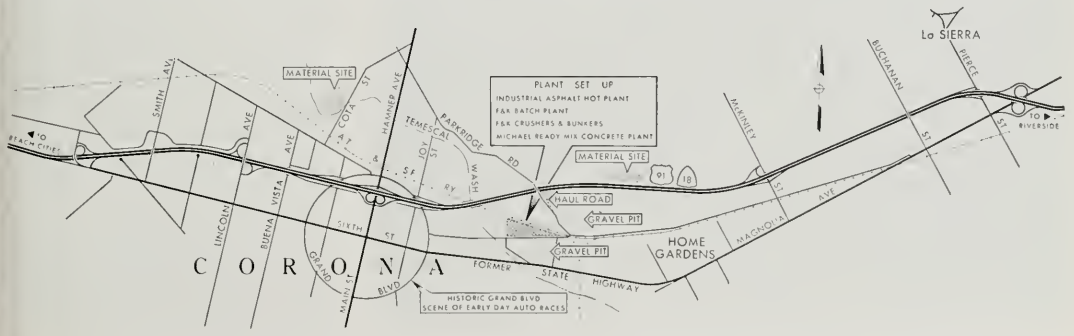


The Grand Boulevard Undercrossing with historic Grand Boulevard passing underneath. Existing trees were preserved wherever possible.

The Circle

Although the freeway bypasses the business district of Corona, it has one feature in common with the former highway—it also crosses the historic circular street known as Grand Boulevard.

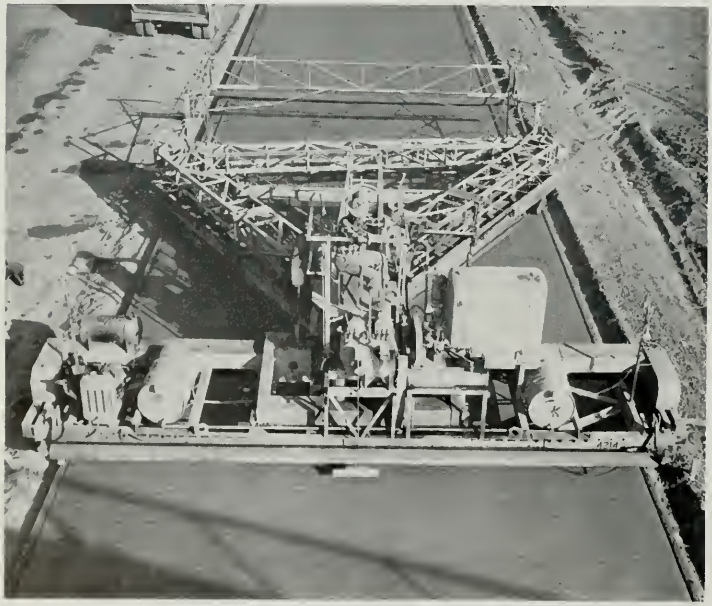
In 1866, the city founders decided that a perfect circle, divided into four quarters, would provide the main arteries of the city they named "Co-



A map of the freeway through Corona which also shows the location of the plant and material sites used during construction.



Corona Freeway Construction. A paver deposits concrete on cement-treated subgrade between slide forms for 24-foot-wide pavement. Following are a spreader, two finishing machines and a float.



A float makes the first of three passes over a section of concrete. Radial floats are left open, allowing excess concrete to be retained at the edges of the slab to be picked up on the backward pass when the radials are closed. On the third pass, machines drag the float, smoothing the surface and wiping out the herringbone pattern caused by oscillating floats.

rona". The boulevard, as originally constructed, has a circumference of three miles and a width of 60 feet. For more than forty years the boulevard was unpaved, and the ladies and gentlemen in their horse-drawn carriages serenely promenaded the ever-turning avenue; equestrians used it as a bridle path; the loop became an integral part of the then quiet life of the small orange belt city.

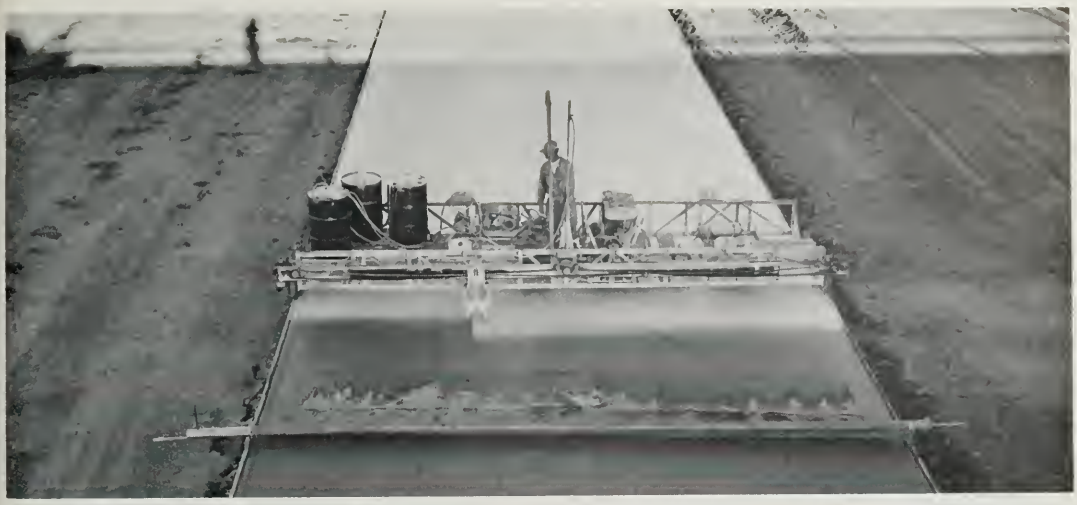
Those quiet times were gone and the horse-and-buggy days were over by the advent of the automobile and the development of racing cars. The potential of this circular avenue as a race track was recognized and, about 1910, the 60-foot roadway was given an asphaltic surface and Grand Boulevard became the first big car race track of the West. Such racing greats as Barney Oldfield, Bob Burman, Ralph DePalma, Eddie Rickenbacker, Earl Cooper and Eddie Pullen roared over the course at nearly 100 miles per hour. As many as 75,000 eager fans would gather in the City to witness the racing events which were held during the years of 1913, 1914 and 1916.

Big car racing on the track was curtailed during World War I and was never resumed in the same style. Today, Grand Boulevard is a well-developed, four-lane roadway, permitting any who might so desire to tour the circle and retrace the route of the racers of bygone times.

Saves 20 Minutes

The construction of the bypass project completes this section of the Riverside Freeway to full freeway standards for a total distance of 24 miles, from its terminus at the junction of the San Bernardino Freeway east of Colton. The remaining section of Riverside Freeway in Riverside County, between this project and the Orange County line, is a four-lane divided expressway. Plans are now being prepared to convert this 3.8-mile section of expressway to a six-lane full freeway.

The Corona project is the sixth unit of the Riverside Freeway in Riverside County to be constructed and opened to traffic since 1955. Construction of the various units has been continuous, following soon after establishment of



Applying white curing compound to completed pavement. The burlap drag across the pavement (foreground) marks the beginning of the next section of pavement being finished by the float (see previous photo).

freeway routings and development of plans. The first public hearings to decide freeway routings were held in Riverside, November 6, 1952, and in Corona, March 29, 1956. The Riverside Freeway was officially named by the California Highway Commission in October, 1957.

With the addition of the Corona project to the other completed construction on the Riverside Freeway, the devious routing of U.S. 91 and State Route 18 through Corona, Riverside and Colton has been eliminated. The improved routing on the freeway is one-half mile shorter than the old alignment of U.S. 91 and driving time has been reduced by 20 minutes. This improvement will be particularly noted by drivers who travel between the interior valleys and the beaches and by the coast-to-mountain recreational traffic. Based on present-day traffic volumes, it is estimated the traveling public using the Riverside Freeway will realize an annual saving of $7,000,000 because of this reduced distance and travel time. Three railroad grade crossings are eliminated.

The Corona project consists of a four-lane divided highway, with provision for future widening to eight lanes with a 22-foot minimum width of median. The through lanes were constructed of Portland cement con-



Looking westward through Corona with the Temescal Wash Bridge and Overhead in the foreground.



Lineup for the Corona Road Race on Grand Boulevard, November 26, 1914. Photo by H. E. Roberts.

crete over cement-treated subgrade. The ramps and loops were paved with asphalt-concrete over cement-treated base, and frontage roads and streets were paved with asphalt-concrete on untreated base.

SAND HILLS

Continued from page 17 . . .

load will provide approximately 23 to 26 cu. yds. of compacted embankment. The rated capacity of the machine is 24 cu. yds. struck, but the scrapers were extended 22" by splicing in steel plates. Sideboards were added on top, increasing the capacity by about 25%.

The embankments are constructed several feet wide on the northerly side, as the prevailing winds erode and carry away considerable amounts of sand from the slopes during construction. Most of this sand is deposited on the leeward side.

Attempts to reduce erosion by watering during windy periods are usually effective, although expensive.

It is planned to blanket slopes most subject to wind erosion with a gravelly material. It is estimated that such treatment will cost about $0.25/sq. yd. Asphaltic emulsion or resin solution treatment of blow sand is also planned. During a day of high north winds, several feet of unprotected embankment may be eroded on the windward side, with a heavy deposit on the lee. Southerly winds appear to be of less velocity and only small amounts of sand are returned during periods of south winds.

All borrow material is pre-wetted in the pit area by means of sprinkler systems. Water was obtained from the All American Canal which generally parallels the project. Water is pumped by three 185 HP pumps through two 6-inch water lines to the pit area, each pump producing up to 1300 gal min. Up to 1,500,000 gallons of water per day is sprinkled in the pit areas. Approximately two-thirds of the water applied to pit areas fails to reach embankments due to evaporation and percolation losses. The contractor applied additional water to embankments by means of water trucks equipped with large oversize tires (17.00 x 20.00 22 ply). Optimum moisture content of the blow sand, as determined by the California Impact Compaction Test, is approximately 12% of the dry weight of the sand. Tests indicate that the moisture content of the sand, a few minutes after saturation is rarely in excess of 5% due to loss by percolation.

Compaction Easily Achieved

Embankment relative compaction of 100%+ is easily achieved by routing of hauling equipment. Outer edges of embankments are compacted by a track-laying tractor or by sprinkling with water.

Success of the existing highway through the sand dunes and the anticipated success of the present construction depends upon the fact that the dunes, while moving, do not increase in height. The road, therefore, is built on embankment over the tops of the dunes. The increased velocity of the wind over the smooth pavement, combined with the action of passing vehicles, keeps the road clean even during the heaviest sand storms. A deposit of sand was recently observed on the low side of a 4% superelevated curve. It is anticipated that this condition can be corrected by covering a wide adjacent area with a gravel blanket. The median of this four-lane freeway will also be covered with a gravel blanket.

BRIDGE PROGRESS

Continued from page 24 . . .

(1) Foundation contract Main Bridge by Yuba Consolidated Industries, Inc. $5,769,000

(2) Superstructure Main Bridge by Yuba Consolidated Industries, Inc. 8,500,000

(3) Solano County Freeway approach by Fredricksen & Watson Construction Co. 4,200,000
This contract includes the Administration Building and Toll Plaza and the approach freeway from bridge end to North Benicia City Limits.

(4) Right of Way Clearance Contract by Fredrickson & Watson Construction Co. $1,025,000
This contract is for work in the Benicia Arsenal relocating existing buildings, storage yards, and other facilities within the highway right of way.

(5) Contra Costa County Freeway by Peter Kiewit Sons Company 4,700,000
Includes freeway approach work from the bridge end to a connection with the Arnold Industrial Highway Route 106.

(6) Widening Escobar and Howards Streets by Gallagher & Burke 425,000
This contract provides for a connection from the freeway to the center of Martinez at Alhambra and Berrellessa Streets.

(7) The Toll Collection Equipment by American Electronics, Inc. Taller Cooper Division 194,000
This contract provides for the installation of toll collection equipment in the toll booths and administration building.

These contracts are all timed to be completed for opening the bridge to traffic by the summer of 1962.

87.4 MILLION DRIVER LICENSES

A total of 87.4 million motor-vehicle operators licenses were in force in the United States during 1960.

The estimate, prepared by the U.S. Bureau of Public Roads, was 3.4 percent higher than the 84.5 million total in force during 1959. There were 1.20 licensed operators per registered motor vehicle.

Traffic Striper

New Machine Now in Service Has Flexibility and Ease of Control

By J. J. KELEHER, Associate Equipment Engineer

The painted center stripe, probably the most used and abused phase of our highway system, is taken pretty much for granted by most of the motoring public. Upon reflection, however, most would agree that, despite its lowly position, it probably exercises a greater influence for safe driving than any other device used on the highway today.

This continuing influence is maintained only by a rigid program of maintenance, and a continuing search for better ways to carry the message of safety to the millions of motorists and pedestrians that use our highways and streets.

The program of striping is an item of considerable importance in highway maintenance, not only from the dollar angle, but in the planning required in the job itself. This must include such problems as traffic, temperature, weather conditions and many other factors. It is a job demanding a high degree of skill, patience and fortitude on the part of the operator who works under some of the most hazardous conditions to be encountered in highway maintenance.

Seek Better Methods

The Equipment Department of the California Division of Highways, in conjunction with the Maintenance Department, is constantly seeking improvement methods and equipment for a safer and more economical approach to the many and varied jobs to be done. In most instances suitable equipment can be purchased on the open market, and we prefer this method of obtaining it. But when specialized equipment is not available, then the Equipment Department is called upon to design and construct whatever is required to do the job. Traffic marking equipment is presently included in this category, but private manufacturers are making rapid advances in this field and should soon be in a position to supply the market.

The needs of the Division for traffic striping have been under constant study with the idea of developing better machines that would accommodate themselves to all of the various types of roadways that make up our highway system. Two years ago, in cooperation with the Maintenance Department, work was undertaken on a new model that would place the operator in the truck cab, and paint more miles of stripe at a lower cost per mile. An article published in the January-February 1960 issue of *California Highways and Public Works* described the prototype of this machine.

Since then, testing and improving of the original model have progressed to the stage where we now have in service a machine that embodies all the basic features originally planned, plus some additional improvements which add to the flexibility and ease of control.



This high crown secondary road presents no problem to the new striper with its narrower tread.



The striper unit is readily loaded and transported on the modified hydraulic tailgate.

Safety for Operator

At the request of the Maintenance Department, primary importance was attached to placing the operator in the truck cab. This was not only because of the operator's vulnerability to accident while being seated in front of or behind the truck, but to help relieve him of the stress and discomfort that has always accompanied his exposed position while operating this type of equipment.

Operation is now controlled entirely from the operator's seat in the truck cab. The cycling device is powered from the truck and consists of a proximity switch with relay, energized intermittently by a rotating mass of ferrous metal mounted on a non-metallic disc. Full compensating controls are provided to meet any standard cycle or stripe pattern desired. Broken stripe may be lengthened or shortened, advanced or retarded, or suspended completely in either phase of the cycle through the operation of micro switches located on the dash. The amount of advance or retard, or the suspense operation is clearly indicated on a specially constructed dial indicator located in front of the operator.

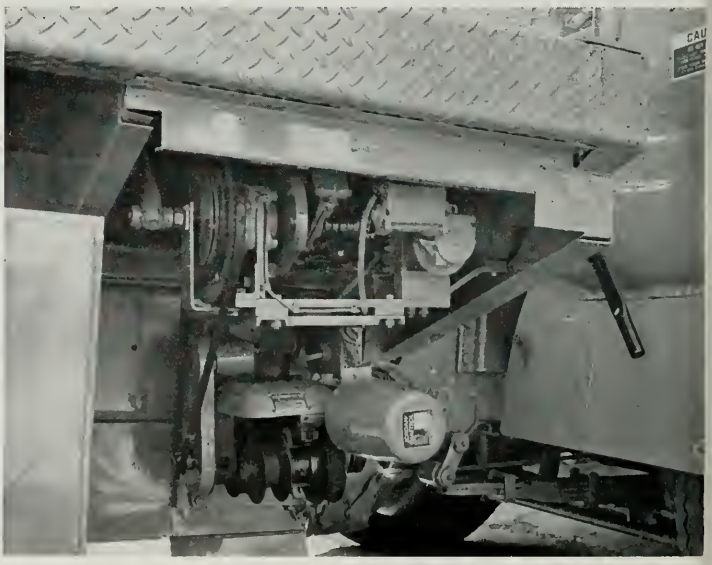
A battery of 12-volt D. C. solenoid valves is used to control the air flow to the paint guns and beaders. Two standard paint guns revamped to give a common outlet (nozzle) are mounted on each side.

Pattern Can Be Selected

This makes a very satisfactory arrangement when yellow and white paints are being used. The operator has only to select the pattern required (broken or solid), and the appropriate color is automatically selected and applied with no noticeable contamination.

The sulky or carriage consists of a simple frame supported on four low-pressure tires and designed to afford the operator full view of the paint guns without having to take his eyes from the road ahead. It is free to float and pivot within the length of the bumper to negotiate some of the sharper curves of the mountain areas without running over the stripe.

The coordination of effort that is required between the truck operator and the operator of the sulky is made less critical through the use of a device that reflects the movement of either unit in relation to the other. A target mounted on a nylon cable moves across the lower section of the windshield in direct relation to the movement of either vehicle so that coordination is maintained by use of witness marks placed on the windshield.



The cycling mechanism is mounted under the body behind the cab.



Cab interior showing the control panels. Steering and controls of the unit can be handled by one man.

Advantages Over Old Model

All these are obvious advantages over the old model where the operator is required to steer, manipulate valve handles for pattern changes, match the existing stripe and frequently check the operation of the guns located beneath his feet, while during his leisure moments he may contemplate the unhappy possibility of meeting the all-too-frequent driver who insists on taking his half of the road from the middle.

As a result of the article previously mentioned, we have had numerous requests from other states for plans and specifications. Australia has manufactured several of the older-type units from our plans and is now operating them. Representatives from their various highway departments have visited here in the past year and requested data on the new machine when completed. This information will be forwarded to interested parties in the near future.

Reports from the districts that have used this new model are favorable. The machine should cost less than the older model. With better controls, less operator fatigue from operation, and better safety for the operator, the cost per mile of stripe should be reduced. With these advantages, the new model will rapidly replace the operator-driven sulky models presently used.

It's the Collier Tunnel and Thomas Bridge

Two of the current construction projects on California State highways have new official names as a result of action of the 1961 Legislature.

By adopting Senate Concurrent Resolution 74, the Legislature designated the tunnel now under construction at Hazelview Summit in Del Norte County, near the Oregon line, on U.S. 199 as the "Randolph Collier Tunnel." This project has been described in two recent articles in *California Highways and Public Works*.

The Legislature also adopted Assembly Concurrent Resolution 131, designating the toll bridge now under construction between San Pedro and Terminal Island in Los Angeles County as the Vincent Thomas Bridge.

Division Approves New Sign Routes

Four new state sign routes and two changes in previously designated routes have been officially approved by the Division of Highways since January, 1961.

New state sign routes are as follows:

State Sign Route 84 in San Mateo and Alameda counties, extending from the junction with State Sign Route 1 at San Gregorio to the junction with U.S. 50 (Interstate 5W) near Livermore. The route passes through La Honda, Woodside, Menlo Park, Fremont, Newark, Sunol, and Livermore, and extends across the Dumbarton Bridge.

State Sign Route 68 (Salinas-Monterey Highway) in Monterey County, extending from State Sign Route 1 in Monterey to U.S. Highway 101 in Salinas.

State Sign Route 59 in Merced County, extending from the junction with State Sign Route 152 at the Red Top Wye, seven miles east of Santa Rita Park, to Snelling. The new route passes through Merced.

State Sign Route 154 in Santa Barbara County, extending from Surf to the junction with U.S. Highway 101 west of Santa Barbara. The new route passes through Lompoc, Buellton, Santa Ynez and San Marcos Pass and was formerly the western half of State Sign Route 150 connecting Surf and Santa Paula.

Changes in existing routes are as follows:

State Sign Route 108 in Stanislaus, Tuolumne, and Mono counties, now extends from Modesto through Yosemite Junction near Sonora to Sonora Junction (U.S. 395 Junction). The change causes SSR 108 to coincide with SSR 120 between Oakdale and Yosemite Junction. Previously SSR 108 extended from Yosemite Junction to Sonora Junction.

State Sign Route 150 in Santa Barbara and Ventura counties, now extends only from the junction with U.S. Highway 101 east of Carpinteria to the junction with State Sign Route 126 in Santa Paula.

California Roadsides—4

EDITOR'S NOTE: This, the fourth and last, in a series of articles on landscaping and related roadside problems on the California State Highway System, covers the choice of plants used for planting on California roadsides, and the reasons why. The four articles in this series, plus a list of most used trees, shrubs, and ground covers, will be made available to interested persons as a reprint booklet under a single cover.

The series has been prepared by John Robinson of the Public Information Section with the assistance of various staff members concerned with planning, planting, and maintenance of roadsides.

BELOW—U.S. 99 on-ramp in Kern County has lawn, oleander, vinca and haneysuckle on slopes. Trees are eucalyptus comaldulensis (rostrata), one of the most useful eucalypts.



As has been pointed out in the preceding articles of this series, the cost of creating artificial environments for plants is too high to be warranted except in special cases, so their ability to survive the environmental conditions on California roadsides must be the major factor in choosing them. The working list of plants and trees used by the Division of Highways Landscaping Section today represents an accumulation of more than 30 years experience in choice of trees and plants for growth under difficult and varying conditions.

Actually, this experience started more than 60 years ago when the first extensive plantings of roadside trees in California began, but many organizations did the planting and records are sparse. We know little about the plantings that failed, but some of these early plantings are magnificent trees today. Fragmentary sections of these old plantings can be seen where they have survived the rigors of the years.

In the Central Valley huge blue gum eucalyptus, native black walnuts, sycamores, and a few oaks and elms still remain of these old plantings. In the Mother Lode country ancient black locusts, Chinese tree of heaven, and Lombardy poplars are accepted as part of the "gold country" scene. In southern California there are fine old peppers, black acacia, cottonwoods, silk oaks, palms, and of course the omnipresent blue gum. Very old plantings of olives may be seen occasionally in the vicinity of old missions and homesteads. Today almost all these species have been superseded for highway purposes because they have some defect in their habit such as slow growth, brittleness, or they require excessive maintenance.

A second surge of roadside planting began in California in the period within the few years on either side of 1915. These plantings in most cases were spontaneous local community efforts, with choice of species too often made by some individual with a fond memory of a romanticized home town location like Fairmount Park in Philadelphia or Mount Vernon in Virginia. The concept of the highway right-of-way at this time also was a vague and tenuous thing which allowed adjacent property owners considerable say on road side matters. In the old type agreements a property owner might have a clause stipulating the variety of tree to be planted!

Even of these later plantings, no one today can say with any certainty how many were wasted, but in 1918, when the Highway Commission took over all the trees along state highways, many unsuccessful plantings had to be replaced. For instance, young trees had been planted in the few inches of topsoil over hardpan without breaking the hardpan. Some of these trees were growing only an inch or two a year. In many places virtually the entire planting had died because the species chosen could not survive through the

arid California summers. Still other plantings had to be removed because they were too close to the roadways.

A state nursery at Davis was established so that adequate supplies of young trees would be available. In 1921 a total of 7,600 black walnut, European sycamore, Lombardy poplar, American elm, and black locust were made available. Increasingly large numbers were released each year and by 1927 the Highway Commission could say it had taken over or planted 60,000 trees on state highways.

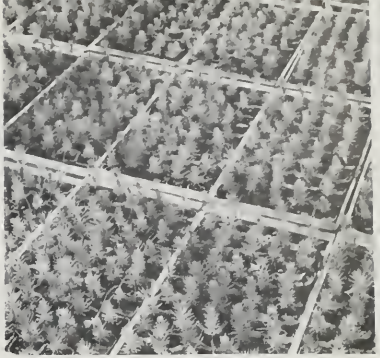
In addition to the above varieties, trees being planted in the valleys included blue gum, red gum, olive, Carolina poplar, silver maple, Arizona ash, and valley live oak. Redwoods, live oaks, maples, walnuts, gums and sycamores were being planted along the coast. In the deserts the trees being used were black locust, Arizona ash, blue gum, red gum, black acacia, and athel (tamarix articulata).

Little work was done with shrubs until the middle of the 1920's, when a movement for beautification of entrances to cities gathered impetus. Tree and shrub groupings were planted at the outskirts of cities, both on county roads and state highways. Plantings also were made near and on the slopes of the many railroad underpasses which were being built at this time.

As the highways became ever wider and straighter, the search for methods of stabilization of the growing number of cuts was intensified. One of the first laboratories for this work was the scenic highway in the Angeles Crest and Crest Drive area above Los Angeles and San Bernardino.

This was a new section of road, built on the side of steep mountain slopes, and necessarily the construction left a number of scars on the mountainsides to be covered. Many of the new cuts and fills were unstable in wet weather, with resultant maintenance problems.

Although many agencies were experimenting with plants to hold cut and fill slopes, there was no way to hold the soil long enough to get growth started. All sorts of elaborate arrangements of brush, wire, wattles, and wooden frameworks were tried. H. Dana Bowers, who was then the entire landscaping section, personally visited some of these new slopes when rain was falling. He noticed that where old grass stems were mixed in disturbed soil, and where the surface was compacted, erosion did not easily begin. The grass kept the water from forming into streams and gullying.



Seedling scotch pines in flats in state nursery.

From this study grew the present practice of working straw into all new fill slopes to hold the soil preparatory to planting or for natural revegetation. The steeper slopes, however, still must be held by some mechanical means until the plants are thoroughly rooted.

At first these were day labor jobs, and the straw was worked into the soil with shovels. Later as the scope of the work increased, the erosion control work was handled by contractors, and a sheepsfoot roller was used to force it into the soil. This type roller was not very satisfactory, as the broadened tips on the sheepsfoot



Sketch shows idealized versions of most useful types of trees and shrubs for roadsides planting. Trees should be upright in habit, fairly light in form, without branches which spread out and obscure vision. High and medium screen shrubs, as well as lower ones used for ground cover, should all hug ground outward from trunk to keep weed growth down.



Black dots indicate place of origin of approximately one hundred trees, shrubs and vines commonly used for planting on roadsides in various parts of California. Much the largest number of plants comes from Mediterranean type climates, or steppe climate areas close by. Note that great sections of the earth are

pulled much of the material out again. A modified form with smaller points was tried, but this left pits in which water collected. Eventually the special roller used today was evolved from a design by Landscape Contractor Bailey Justice. This is a roller similar to a sheepsfoot, but with what are essentially thick disks extending from it parallel to its direction of movement, instead of the peg shaped extrusions of the sheepsfoot.

The Division of Highways began to acquire real experience with shrubs with the onset of the depression of the 1930's. Much highway beautification sprang from depression "make work" programs, and Federal highway money grants during this period specified a certain small percentage was to be spent on landscaping.

By the early 1930's also, plants were being used for functional planting. The virtues of ice plant as a bank cover had been discovered, and studies of ground covers for fire control and weed control were well along.

Experiments with true xerophytic plants—that is, plants which are highly drought resistant—proved disappointing. Although they survived under very dry conditions, they became dormant during the summer and dried out to such an extent they became a fire hazard.

At that time, even as today, there was considerable public pressure to plant "natives" along the highways. This is not always practicable. Most of California's native plants have adapted themselves to one particular climate or condition and are unhappy under other conditions. Dozens of species of ceanothus, for instance, grow in the state, each species adapted



not represented, and that there are virtually none from the interiors of any of the continents. The black arrows in the oceans mark cold currents from the poles, which are generally associated with Mediterranean type climates.

to one locality. But of these many species of ceanothus, only three or four are useable. The same thing is true of the manzanitas, which have almost as wide a variation of types in the state as do the ceanothus.

As an example of the problems of using "natives," the Federal Government's experience in 1957 with the slopes in the vicinity of the new Air Force Academy in Colorado may be cited. About a thousand ponderosa pine seedlings, native to the area, were planted on a south-facing slope which got the full effect of the sun's rays. Because of the southern exposure, watering through the summer was contracted to give the baby pines a fair chance. In supplement to this watering, 1957 turned out to be the heaviest rainfall year on record, yet fewer than 3% of these seedlings survived the first year.

At the time these were planted, several thousand other ponderosa seedlings were planted on nearby north-facing slopes, but received no care. Survival among these trees was better than 90%.

Residents of California and other semi-arid states will see this effect of north and south exposure demonstrated many times where the land is hilly. Northern slopes will often be covered with dense growth, while southern ones will have only thin carpets of dried grasses and a few, scattered, wizened shrubs.

Obviously, the simple term "native" is misleading. The state has many local climates, resulting not only from exposure, but also from latitude, from nearness to or distance from the ocean, and from altitude, to list a few of the

determining factors. Comparable combinations of these factors are apt to occur in only limited areas of the earth's surface.

To test the value of California natives for roadside use, experimental native plantings were made a number of places on the southern part of State Sign Route No. 1, which travels along or close to the ocean, and enjoys the climate modifying effect of moist ocean winds. Gaviota Canyon, Carmel Hill before the freeway was built (and recently replanted to natives), and the expressway just south of Santa Cruz are three of these sections where natives were used successfully. An inland area in the vicinity of the Devil's Gate Dam, in the San Gabriel Mountains, was also successfully planted to natives.

Many of these plantings still survive, and are very attractive today. Some of the shrubs have died out, but have been replaced by "volunteer" plants from windblown and birdborne seeds. On the other hand, results with California natives in the median of today's divided highways have been often indifferently successful, occasionally dismal failures, since the surplus of run-off water in any median is a drainage problem.

A constantly recurring request to the Division of Highways is for the planting of California Poppies, lupine, and other wild flowers. These flowers are still being planted on new construction whenever conditions are right, but they normally do not survive long. The first year they make a brave show, but quickly disappear after that, as the coarser grasses crowd them out.

One of the more difficult jobs from which valuable experience was gained was the planting of the San Francisco Bay Bridge approaches. On the Oakland end the fill was sand dredged from the bottom of the bay, and many truckloads of topsoil and manure had to be imported to make it suitable for planting. Before planting, young shrubs and trees had to be acclimated in a semi-exposed location for several months, otherwise they would have been rapidly burned to the ground by the force of the salt-spray laden wind.

Some non-coastal trees were planted such as incense cedar, Atlas cedar, and coast redwood which, despite its name, is rarely found in exposed coastal locations. These survived if protected by more hardy varieties. Lawson cypress from the Northwest failed completely. In the most exposed locations the shrubs and trees that survived were three of the hardiest California natives — Monterey cypress, western elderberry, and baccharis. Two melaleucas, (nesophila and armillaris), pittosporum crassifolium and the Australia tea tree also proved very resistant to drenching with salt spray. Ice plant ground covers stood the difficult conditions well, seemingly completely indifferent to the salt.

When the Pasadena Freeway (then called the Arroyo Seco Parkway) was built in Los Angeles the depressed sections were in cuts with steep slopes in order to save right-of-way costs. This freeway became a test section for ground covers, of which every available variety was planted to determine its suitability.

Few proved suitable. Wild strawberry, rosa wichuriana, and vitis capensis were not vigorous enough to compete with the rampant weed growth. Bougainvillea and climbing roses did well but did not smother out the weeds. Virginia creeper was also a vigorous grower, but deciduous in winter. Honeysuckle developed beneath its green surface masses of dead, woody stems which would catch fire in the afternoon even if watered that morning!

Morning glory was inconsistent. In some places it would grow poorly, in others rampantly climb upon itself until it was grown up into great humps and mounds, with much dead wood underneath. Ivy geraniums did not live long enough to be worth the trouble of planting. Hypericum required too much water. Nepeta hederacea failed miserably in the southern California climate.

Surprisingly, a small planting of mesembryanthemum croceum did well on unfertilized, decomposed granite. Vinca periwinkle was not satisfactory on slopes, although in other locations it has proved very valuable. The best cover was the common English ivy, which was used extensively for several years. Recently it has been supplanted by the Algerian ivy, which grows faster and has a more glossy leaf surface. Another very successful ground cover on this freeway was lantana sellowiana.

A study of the California Division of Highways preferred plant list will show that more than 90% of the plants used in roadside planting are native to Mediterranean or steppe climates. This is not a planned result, but is an empirical one learned during 30 years of trial and error. It is no accident these Mediterranean plants have come to the fore, because they are adapted to Cali-

Pala Verde trees growing on U.S. 99 in the Imperial Valley. These are native trees adapted to this true desert climate and soil.



fornia almost as well as the truly indigenous ones. Conversely, many California natives are planted in these other Mediterranean areas of the world.

California is called by geographers a "coldwater coast," or "Mediterranean," climate, which gradually shifts into a "sub-tropical steppe" climate inland and to the south. Only about 2% of the earth's surface enjoys a Mediterranean type climate, and these areas are found where prevailing westerly winds blow across cool ocean currents onto the land—in other words, always on the western side of continents, and near the middle latitudes. Mediterranean type climates are found in California, Chile, on the west and south coast of Australia, and at the southern tip of Africa, as well as in a deep penetration into the Afro-Eurasian land mass around the sea which gives the climate its name. Mediterranean climates are characterized by dry summers and even temperatures the year round.

Mediterranean climates are inevitably accompanied in the interior and on the equator side by the sub-tropical steppe climates. These climates are dryer, with hot, dry summers. Winter rainfall may vary greatly from year to year, but it is never heavy. Such climates are found in the southern Central Valley of California, Lower California peninsula, and north Africa.

Naturally, over the years, botanists and plant scientists have imported the best plants from all over the world which are adapted to these climates. The hardiest of these, after years of study and testing, have been adopted for use on California roadsides. The plant list used today by the Landscaping Section is a mixture of American and foreign plants, often used in cosmopolitan combinations.

Despite occasional public criticism that an insufficient number of California shrubs and trees are used, the Landscaping Section has more than 30 California natives on its list, as well as a few more from adjacent Southwest areas, such as the Mexican fan palm, and the Arizona cypress. Actually, California is the heaviest represented area on the list. Furthermore, in a survey of several Division of



Chart shows relative number of trees, shrubs, and vines used in California roadside plantings from various parts of the world.

Highways landscape architects and landscape maintenance supervisors, four California natives were unanimously chosen to be included in the twelve plants voted most useful for highway planting in this state. These were California toyon, coast redwood, California sumac, and the palo verde.

The second largest group of plants and trees, totaling about 25 in all, comes from Australia and New Zealand—mainly the former. These are the bottlebrushes, the pittosporums, the tea trees, but most important, the acacias and the eucalypts. Fast-growing, drought resistant, frost hardy over much of the State, generally insect free, evergreen and graceful, these exotics from the Antipodes have taken to California conditions as though they were native.

Another group of plants on the preferred list, almost a score, in fact, comes from eastern China and Japan. Some of these plants are steppe-born, some are developed from centuries of oriental gardening. Perhaps the greatest gift from this area is the pyracantha, which, like the Australian plants, also takes to California like a native. (One common pyracantha, coccinea, comes from southern Europe, but this is not generally used on roadside plantings). Two very useful vines, the Japanese creeper and Halls Japanese honeysuckle are native to east Asia. This area also gives us the camphor tree, the ginkho, forsythia, crepemyrtle, and the Pfitzer juniper.

A smaller group of plants, about 10 altogether, comes from the shores of the Mediterranean. This region's most important contribution can unreservedly be said to be the oleander, which the Division of Highways has planted by the hundreds of thousands. Other good imports from this region are the carob, pomegranate, Algerian ivy, and the Aleppo pine.

A few old favorites from non-Mediterranean Europe have proven able to exist in the California climate without excessive care. One of these that has proven very useful as a ground cover, particularly at interchanges, is the vinca, or periwinkle, which made such a poor showing on the Arroyo Seco plantings. This is a very hardy ground cover. Its first cuttings were

no doubt brought to California in sailing ships around Cape Horn. Patches of it can be seen many places in the state around old home sites where the buildings long since have fallen into rubble.

Seven trees from the eastern U. S. are in constant use in the planting plans today also. These are the Southern magnolia, liquidambar, pin oak, tulip tree, scarlet oak, catalpa, and thornless honey locust. Tested year after year, these have all proven hardy, reasonably fast growing, and ornamental. Because they are native to a year-round rainfall climate, they all require considerable watering until they are well established.

Except for these few trees and a scattering of shrubs from places such as India, Central America and tropical South America, the rest of the list is made up of miscellaneous Mediterranean or sub-tropical steppe trees and shrubs. It should be noted that only a single shrub from the eastern U. S. has proved satisfactory on roadsides in California, the Carolina cherry.

Of all the imports from the various continents, and excepting the oleander, those from the New Zealand-Australia archipelago would be the hardest to get along without. Among the tea trees, bottle brushes and pittosporums are found species which grow in the most impossible locations—on high, arid, windswept ridges, along the beds of dry rivers, and almost in the surf of the Pacific where they are constantly drenched with salt-spray. The acacias we use, all of which are native to Australia, are legumes, which make them particularly adapted to California's normally nitrogen-thin soils.

We especially thank Australia for the eucalypts. Although very few of the many hundreds of native Australian species of this tree have been imported, their mark on the state's landscape has been tremendous. In fact, many people think the eucalyptus a California native.

The first experimental plantings of eucalyptus in California toward the end of the last century were almost exclusively blue gum (e. globulus). There is hardly an older farm home in the valleys of the state that does not have at least one of these trees. Because of their fast growth and great size, these trees are popularly supposed to be much older than they are.

In the early 1900's experimental commercial plantings of this tree and a few other species were made many places in the state as a new and highly promising source of timber. Perhaps as many as two million acres were planted. For various reasons the plantings did not prove commercially feasible. Eventually it was realized the native conifer forests were the best timber producers for California, and this only where soil and rainfall were favorable.

Blue gum is not used on roadsides today because it gets too big, its constant leaf drop and bark sloughing is untidy, and its brittleness requires constant maintenance lest its big branches fall into the highway. Because of blue gum's bad characteristics, the entire family of eucalypts has gotten a bad name, and it is not unusual to run into local prejudice when the smaller and better behaved varieties are planted in an area.

The eucalypts used on the highways are the smaller species which have proven just as hardy and adaptable as the blue gum, but do not have the avaricious root system, nor the shedding habits of the larger species. The dwarf blue gum, a rounded, compact tree almost shrub-like in habit, is used extensively for screens. Lehman Eucalyptus or Bush Yate as it is called in Australia, is another excellent low growing variety. Its globular shape and low, spreading branches make it very desirable from a maintenance man's standpoint. Some of the Mallee varieties are being used in recent plantings as decorative shrubs.

Among the tree forms Camaldulensis is better behaved than blue gum. Rudis is used extensively. Polyanthemos and sideroxylon are two excellent smaller varieties for structure delineation and similar uses. These are varieties which have been selected as outstanding after many years experience with them. Dozens of other varieties would probably do just as well if they were available in quantities from the nurseries.

Obviously, the "native" plant for use in planting on California roadsides is the one which can survive conditions which are as difficult as any plant anywhere could be subjected to. Some of them must live where salt spray is continuously coating their leaves, others in a true desert climate. Plants which have evolved to survive in these conditions are the ones that must be planted, as the creation of artificial environments is prohibitively expensive on a statewide basis.

This is the final article on California Roadsides. A reprint booklet is being

New Tree Planting Program Authorized

SACRAMENTO, JUNE 30—The inauguration of a new program of planting and replacement of trees along existing and newly constructed freeways was announced today by State Director of Public Works Robert B. Bradford.

The tree planting program, which will be in addition to the landscaping and functional planting carried on by the Division of Highways for many years, won the prompt and enthusiastic endorsement of Governor Edmund G. Brown.

Bradford said that the new tree planting policy was recommended by State Highway Engineer J. C. Womack and approved by the California Highway Commission. The first allocations for tree planting projects are expected to appear in the State Highway Budget for the 1962-63 fiscal year which the Commission will adopt this fall.

Cost of the tree planting will vary from $100 to $2,500 a mile, depending on the areas involved.

"The tree planting will be particularly valuable," Bradford said, "where a freeway traverses a rural area in which many existing trees have had to be removed from the right of way during construction."

The new program envisions the planting of trees that will fit into local conditions and will not involve maintenance beyond watering them for a year or two.

made of the four articles, plus a supplementary list describing nearly 100 plants and trees. This list is made up of the most useful of these plants and trees as developed over the past 30 years, and describes their habit, adaptability, good and bad points. The list has been compiled in the hope it will be of assistance to communities elsewhere in California and other places in the world with similar Mediterranean and sub-tropical steppe climates.

Doubtlessly there are a number of other plants which could be added to the list—certainly some which are unknown to the Division of Highways landscape architects, and others with which it has not been practicable to experiment. This is not surprising, since botanists have classified more than 120,000 different species of higher order plants in the earth's plant kingdom.

The list then is not to be considered a comprehensive inventory of all the hardy, rugged plants which might be used in difficult situations such as are found along our state highways in California. Rather it is an offering to be added to the literature on such plants. Insofar as possible it records the cumulative experience over a number of years of a number of Division of Highways landscape architects.

For those who refer to this plant list, it must be kept in mind the plants used on California roadsides must satisfy very difficult requirements. Ideally, they must be drought-resistant, adaptable to various kinds of soil, able to take heat and exhaust fumes; preferably be fast-growing, evergreen, and spread their branches close to the ground for weed control. Very few trees and shrubs meet this set of specifications, but in the interests of avoiding montony, a number which approach the ideal are used.

The list is divided into separate sections for trees, shrubs, and vines and/or ground covers. Each of the sections is divided into two groups—those most desirable and a list for second choice or specialized use. Especially satisfactory plants are marked with one or two asterisks, the two asterisk ones being the best.



Hillside in the Santa Cruz area planted with native Monterey pines. These fast-growing native trees are ideal for this climate and will quickly bind the slope.



Screen plantings of dwarf blue gum (Eucalyptus globulus compacta) on Nimitz Freeway in Alameda County. Hardy, evergreen, dense and fast growing, this tree is almost as valuable as the oleander.



Hollywood Freeway in Los Angeles area. Algerian ivy has proved one of the best vines for this type of slope planting, if sprinkling is provided. Screen at top is Japanese privet. Trees are catalpa and liquidambar, both of which will become much more significant in the overall design as they grow larger.

San Mateo Streets

Major Progress Made Under Six-Year Program

By N. B. SMITH, City Engineer, HAROLD PORTER, Assistant City Engineer, JOHN GARD, Office Engineer, and LOUIS FAVRE, Construction Engineer, City of San Mateo

Since 1955 the City of San Mateo has engaged in an enlarged program of resurfacing and reconstructing city streets. This program includes both major city streets and the ordinary city streets. Some normal construction projects requiring acquisition of right of way and complete roadway reconstruction have been completed. However, the emphasis has been on resurfacing not only to improve the riding quality of the streets, but also to strengthen the structural section of the roadway.

A complete study of all of the streets in the city was made and the ones in poorest condition were listed for reconstruction the first year. This same idea has been repeated each year, and at the present time there are no really bad streets in San Mateo. Many are excellent and the remainder are in good condition. In order to obtain the best results, the program has included reconstruction of broken curb and gutter and construction of improved drainage facilities immediately prior to the resurfacing.

A large amount of this preparatory work is done by the city maintenance crews. However, as much as is reasonably possible is included in the contract. In addition to the preparatory work mentioned above, a heater planer is used to trim the edges of the old asphalt pavements adjacent to the concrete gutters. This permits a better joint and a better looking finished roadway upon completion of the resurfacing.



Channelization of the intersection of Parratt Drive and Alameda De Los Pulgas in San Mateo was designed with provision for future traffic signals when needed.

Larger Contracts Economical

Another basic consideration in our program has been to do this work in one large contract. This has resulted in better prices and has required less paper work and has been handled more readily by the inspection department.

The City of San Mateo now has a land area of approximately 10 square miles. There are 49 miles of major streets and 110 miles of secondary streets. In addition, there are 12½ miles of state highways and freeways within the city limits.

Since World War II, San Mateo has experienced typical California growth with many new subdivisions and a considerable mileage of new streets. However, some of these are now 14 to 15 years old and are requiring some maintenance or reconstruction.

In planning this resurfacing program, the city has worked closely with the various utility companies so that any underground work could be accomplished prior to the new surfacing. Plans have been changed several times to permit underground construction. Once resurfacing plans were revised to permit construction of several miles of 24" water mains, at other times, to allow the gas mains and service to be reconstructed. In many



BEFORE—A broken curb, gutter and driveway prior to reconstruction.



AFTER—The curb, gutter and driveway following reconstruction and resurfacing of the street.



East Hillsdale Boulevard, recently resurfaced, serves as San Mateo's major traffic connection between El Camino Real (U.S. 101) and the Bayshare Freeway (U.S. 101 Bypass).

cases these latter are as old as the streets and may be too small as well as in poor condition.

Beginning in 1955, the City placed approximately 8,800 tons of plant mix asphalt on the major and ordinary city streets. In 1956, 23,000 tons were placed; 1957, 23,000 tons were used; 1958, 20,600 tons were used; 1959, 7,200 tons and in 1960, 24,000 tons were used. Prices on the small contracts ranged from $6.41 to $6.80 per ton, whereas, on the larger contracts, the prices have varied from $6.06 to $6.19 per ton. This price of $6.06 per ton was the bid price in 1960 which we considered very favorable in view of the general increase in prices from year to year. The tonnage resulted in over 59 miles of newly resurfaced streets out of a total of 160 miles in the City.

Specifications Conform

The city's specifications conform largely to the State Division of Highways specifications for dense grade plant mix pavement. The contract items consist largely of raising manholes, planing and trimming the edges and the tonnage. Skeleton drawings are prepared showing the widths of the streets, the exact area to be surfaced, the edges to be trimmed and the manholes to be raised.

Specifications are written so as to reserve the right to increase or decrease the amount of tonnage to be furnished by 20% without a change in the bid price. On several occasions blocks have been added to the original contract and in a few cases, a street has been deleted where underground improvements were necessary and could not be made ahead of the resurfacing.

All of the work described above has been paid for with gas tax funds except work by the city forces. This work by the city forces would need to be done even if there were no resurfacing program, but by coordinating it with our resurfacing program, whole areas are put in first-class shape. The city forces make repairs to sidewalks and driveways and repair storm drains without any argument over quantities or eligibility for gas tax. Likewise, a large amount of detailed measuring and inspecting and survey work is eliminated.

In addition to resurfacing and reconstructing described herein, the City has had several other construction projects paid from gas tax during these same years. Other street department activities have been paid from city funds, such as traffic signals, signs, and traffic painting, sweeping and lighting. Likewise, subdividers have paid for new streets in new subdivisions. On this basis the gas tax funds have been adequate and as far as can be foreseen, it will be possible to maintain good streets throughout the city. In addition the city anticipates accumulating some gas tax funds to help pay for a large grade separation structure that is needed.

Structures

Twelve bridges were required. Interchange ramps were constructed at Maple Street, Lincoln Avenue, West Grand Boulevard, Main Street, East Grand Boulevard, McKinley Street, and Pierce Street. West Grand Boulevard Overhead and Temescal Wash Bridge and Overhead carry traffic over two railroads and Temescal Wash. Separation structures serve local traffic on Smith Avenue, Bueno Vista Avenue, Parkridge Road and Buchanan Street.

All bridge structures are reinforced concrete and vary in length from 82 feet to 1,054 feet. The longest bridge, Temescal Bridge and Overhead, is a reinforced concrete T-beam and pre-

. . . Continued on page 69

Merging Traffic

North Sacramento-Elvas Freeway Interchange Is Subject of Study

By LEONARD NEWMAN, Associate Highway Engineer



RECENTLY there has been an increase of interest in the theory of freeway traffic flow throughout the country. Several theories have been advanced as to necessary conditions of traffic flow which will permit maximum number of vehicles per unit time past a given point.

Many researchers say that maximum volumes at a particular location can be attained only with smooth steady flow at some constant speed, in the range of 17 to 35 MPH (a state in which demand would have to be exactly equal to maximum capacity). Once a breakdown occurs, as illustrated by stop-and-go driving at or just before the bottleneck, this school contends that capacity through the bottleneck is greatly reduced because density is high and speed is low. Diagrams of the kind shown in Figure A are used to demonstrate this theory.

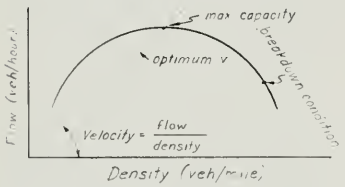


Figure A

Another theory says that the greater the delay the greater the flow. The theory is that maximum output cannot be attained without a steady demand, and in order to supply the steady demand, a queue is necessary. See Fig. B. This approach implies that highest flows are obtained under queuing or stop-and-go driving conditions, rather than with smooth steady flow.

In order to test these theories and to gain additional traffic flow information, a small-scale study was made of a merge of two freeways (four lanes merging into two lanes) in the Sacramento area. The conditions of the site were such that the location of congestion is identifiable, and output traffic flow and input flow (demand) could easily be determined. Absolute demand was known because the backups from the merge did not extend to

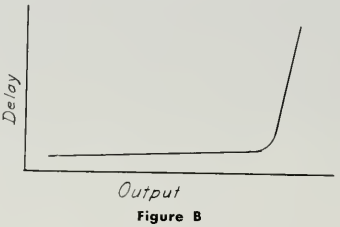


Figure B

the point where input flows were observed.

In summary, results of the study show that:

1. Flow at the merge for significant time periods was not reduced after queues developed. On the other hand, the output flow dropped immediately when the queues were dissipated.

2. As long as there is some queue, the output rate remains approximately the same regardless of length of queue.

3. During queueing, at average approach speeds of 10 MPH with a density (both speed and density actually measured on the ground) of 139 vehicles per mile per lane, the output rate at the merge was 61.5 vehicles per minute or 1840 vehicles per hour per lane.*

These results, along with other observations made in California, generally fail to substantiate the theory that high output volumes cannot be maintained under stop-and-go driving conditions. On the contrary, it supports the contention that high volumes cannot be maintained for significant time periods *without* some congestion or stop-and-go driving. This is because the queue formation reduces the number and size of random gaps which always occur in the traffic stream under free-flowing conditions.

Flow-Density Curve

A diagram such as shown in Figure A is essentially correct if it is drawn for a location on a freeway upstream of a bottleneck. But the breakdown condition on the flow-density curve represents only the effects of a downstream bottleneck and does not have any bearing on the actual capacity characteristics of the freeway.

For example, if a curve were drawn for the Elvas approach in this study, it would probably hold. In other words, the Elvas approach output of 31.5 vehicles per minute at a density of 139 vehicles per mile is very low compared to a normal 2-lane capacity of 60-70 vehicles per minute. The real reason only 31.5 vehicles per minute can travel the Elvas approach is not because of a high density but because an additional 30 vehicles per minute are entering the two lanes at the downstream merge. The point is that the two lanes at the merge have a capacity of 61.5 vehicles per minute and the fact that the Elvas approach volume rate is at a density of 139 vehicles per mile and 10 MPH average speeds is irrelevant.

If observations were made just downstream of the bottleneck, the flow-density curve would not take the same shape as in Figure A. Maximum flow would be reached and the curve would stop at that point—there would be no sharp downward swing toward zero flow. There never is a breakdown condition (stop-and-go driving) downstream of the bottleneck (at the end of a merge or top of a grade).

* This is not withstanding the fact that the merge is too short—dropping 2 lanes in 800 feet. It is possible that higher flow and capacity would result from a longer taper. Other studies indicate that the taper should be at least 1200 feet for merging from four lanes to two. It should also be noted that a downstream on-ramp introduces an additional volume rate of 192 VPH, making a total of 1936 VPH per lane.



Looking south showing the merge of the Elvas and North Sacramento Freeways and the Arden Way interchange, which was the subject of this study.

Curves as shown in Fig. A have led to misinterpretation as to freeway capacity by persons not realizing that these curves depict a mathematical relationship of traffic flow to speed or density, but do not differentiate clearly between cause and effect. They do not necessarily reflect the traffic-carrying capabilities of the freeway where there are more lanes upstream of the bottleneck than there are downstream.

The data collected do tend to support the theory that the longer the time lasts during which queueing occurs, indirectly increasing delay, the greater the output over this length of time will be.

Site and Data Collection

Fig. C and the photograph show the location of the section observed and the geometric conditions at the merge. The site about 4 miles northeast of the center of Sacramento is the merge of the North Sacramento Freeway (U.S. 40) and the Elvas Freeway (U.S. 99). It handles the outbound commuter peak. Both are 4-lane freeways and they join into a single 4-lane freeway (a portion of this freeway is currently being widened to 8 lanes).

Continuous counts were recorded by minute at the three points indicated on the drawing:

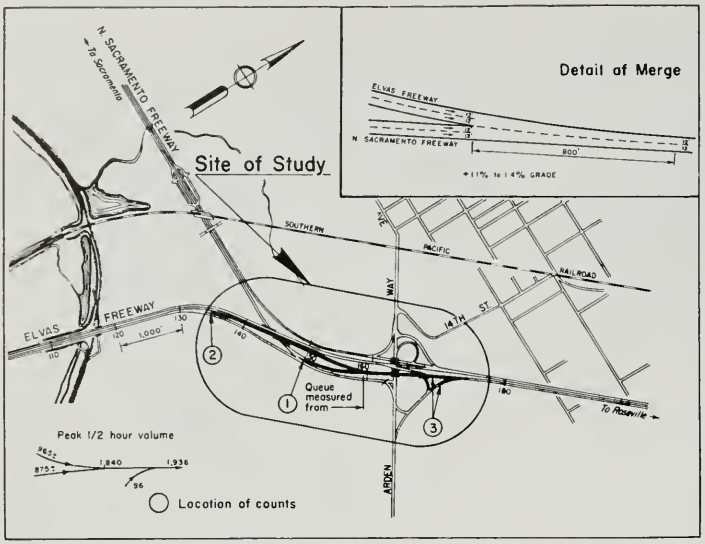


Figure C

1. Input volume from the North Sacramento Freeway
2. Input volume from the Elvas Freeway
3. Output volume of merge and input from the eastbound Arden Way on-ramp. The maximum volume on the freeway occurs at this point. About ½ mile downstream, an off-ramp reduces the freeway volume by 700 vehicles per hour.

The input volumes were recorded far enough upstream (2,500 feet on the left branch and 1,000 feet on the right branch) to minimize the possibility of the queue extending beyond the observation points.

Description Recorded

Along with the counts made at the three observation points, description of traffic flow was recorded, as was formation and length of queue. Determining the tail-end (upstream) of the queue was done subjectively but in practice it was relatively easy within the required limits as there was always a visibly distinct change in density and speed at the end of the queue. The end of the queue was not necessarily where vehicles came to a complete stop, but where there was an abrupt change of density or speed such as from 30 MPH to 5 or 10 MPH.

Queues were measured from the nose of the merge (see Fig. C). Even though there may have been instantaneous stoppages or congestion in the merge area proper, this was not recorded as queuing. Only when stoppages extended to the nose was queuing recorded.

Two men were used at each count location, one for continuous counting and one for recording and observation of traffic conditions and queuing. The entire section under observation was visible from the three observation points.

Counts were not classified by lane and type of vehicle nor were speeds obtained at the observation points although sample travel times between selected points were obtained during varying traffic conditions. Approximately 1 to 1½% of the traffic is trucks and buses.

Results

Data collected on March 9, 1961 are presented in Fig. D. Traffic flow was typical for peak hour operation in the middle of the week.

Between 4:40 and 4:54, traffic was generally free-flowing (except for the period 4:45 to 4:47—a vehicle stopped in the merging area to let a passenger off, causing considerable congestion. The minute following this stoppage had the highest volume observed during the study.) Speeds approaching the merge during the beginning of the free-flowing period averaged between 55-60 MPH, and at the merge and beyond averaged 40-45 MPH.

Between 4:54 and 5:10, there was congestion at the merge with some stop-and-go driving. Most vehicles applied their brakes at the merge. However, no queuing developed during this period. Speeds at the input observation points remained high. There was some congestion at the downstream entrance ramp, but this congestion seldom, if ever, backed up as far as the freeway merge being studied.*

At 5:10, queues developed on both approaches to the merge, primarily on the Elvas approach. The longest back-up on the North Sacramento approach was only about 250 feet and demand on this approach quickly dropped to the point where there was no more queuing.

The longest back-up on the Elvas approach reached 1,700 feet and occurred at 5:21. Queuing ended at 5:36 and free-flow resumed.

During the peak ½ hour period from 4:54 to 5:24, 1,840 vehicles went through the merge, at an hourly rate of 3,680 (or 1,840 per lane). During this same period, the ramp added 96 vehicles (192 VPH). This resulted in a total downstream volume of 1,936 vehicles in one-half hour, or 1,936 VPH per lane.

Capacity Analyzed

The minute-output volumes show that traffic volume rates over significant time periods do not drop when demand increases to the point where back-ups develop. Under free-flowing conditions (between 4:40 and 4:50),

* However, this ramp traffic and traffic weaving to an off-ramp (700 VPH) ½ mile downstream prevents high-speed, free-flowing operation downstream of the freeway merge studied. This may have had some effect on the merge studied since the physical length of a bottleneck may affect its capacity, i.e. if the bottleneck is short, traffic may be willing to drive through it with shorter gaps.

there are high volume rates obtained for a minute now and then, but these rates are not maintained since low volume minutes also occur due to random fluctuations in demand. In fact, if it were not for these low periods, operation would not remain free-flowing.

High volumes require a constant demand, thus guaranteeing that there will be no periods of low volume.

Apparently the capacity of this particular merge over extended periods is about 61.5 vehicles per minute or about 3,700 VPH regardless of whether demand just equals or is in excess of capacity.

It is interesting to note that between 5:20 and 5:35, output at the merge is slightly reduced even though there is still a queue of vehicles on the Elvas Freeway approach. This can be explained by the fact that the demand on the North Sacramento approach drops to 24.5 vehicles per minute and apparently because of the physical configuration of the merge, the vehicles approaching on the Elvas Freeway cannot take full advantage of the lesser demand on the other approach. Therefore, the capacity of the merge when only the Elvas approach was fully loaded was 59 per minute as against 61.5 per minute when both approaches were fully loaded.*

* There are several hypotheses that might explain why the Elvas approach vehicles could not take full advantage of the greater number of gaps in the North Sacramento Approach:

1. The method of striping (see Fig. C) encourages each approach to merge separately into a single line. Perhaps if lane striping were carried through on the Elvas, higher volumes could be attained.
2. The Elvas approach is on a curve while the North Sacramento is essentially on tangent.
3. The possibility that with other merging conditions being equal the vehicle on the right has a psychological advantage in merging primarily because of better visibility.

Delay and Queuing

If the period between 4:54 and 5:09 is taken as normal and a period of little or no delay, then delay caused by the subsequent excess of demand (reflected in queuing) can be determined. During the normal period, speeds on the approach to the merge averaged about 45 MPH. At the merge itself, speeds were low and some instantaneous stoppages occurred. But no queuing developed.

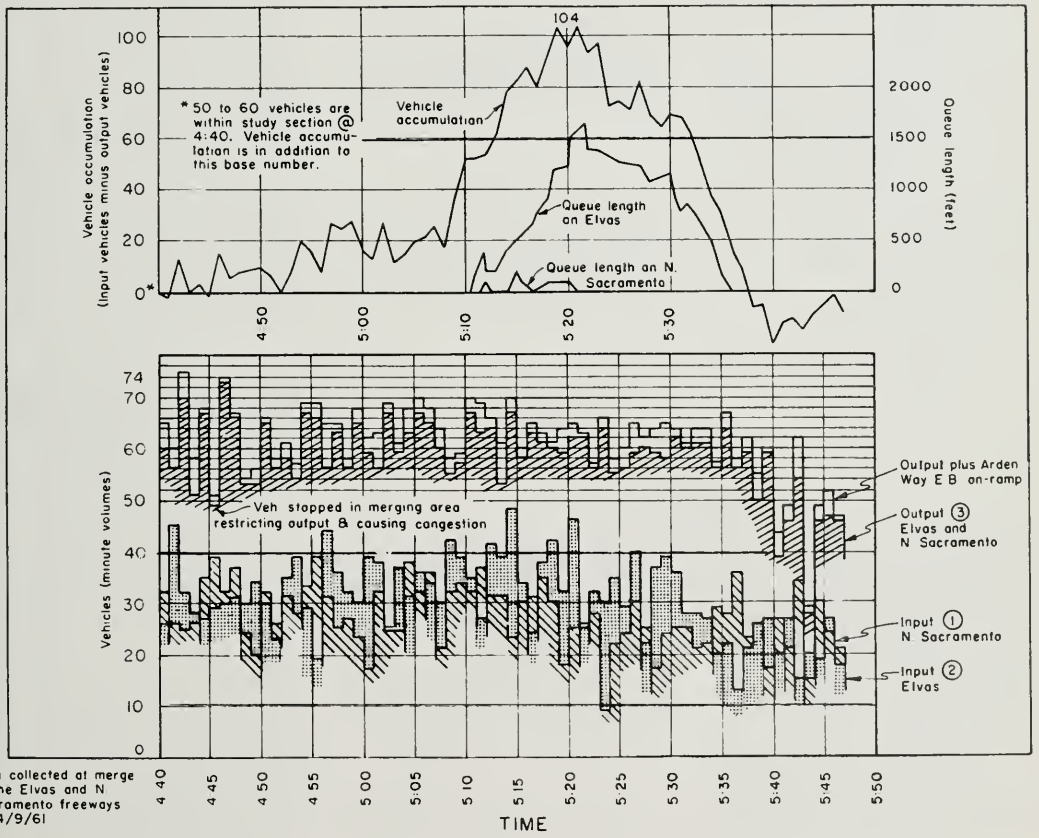


Figure D

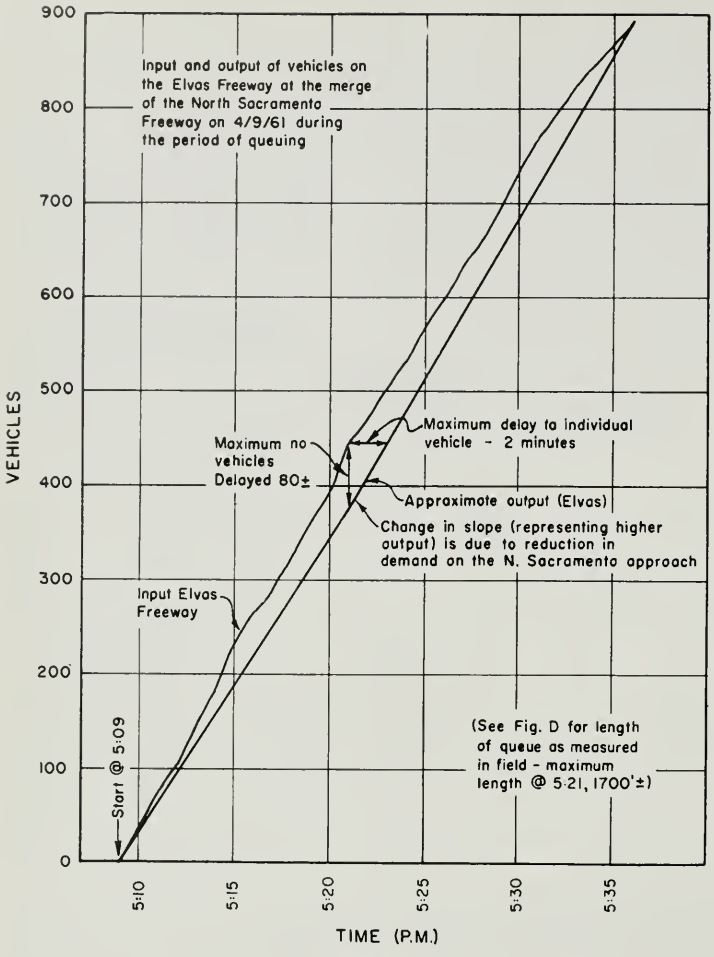


Figure E

The major delay occurred on the Elvas approach. The delay on this approach leg can be analyzed as follows:

The distance between the nose of the merge and the input observation point on the Elvas was 2,500'. Therefore, at a volume demand rate of 33 per min. @ 45 MPH (which was the case during the 4:54-5:09 period), vehicle spacing averaged 120 feet.

At this spacing, there would be about 21 vehicles in the Elvas approach leg during the normal flow period. Eighty additional vehicles had entered the section when the back-up reached its peak (1,700'). At that time there were about 100 vehicles within the section, of which about 90 were in the queue (the other 10 would be approaching the queue in the 800-foot distance between the tail of the queue and the observation point). Assuming an equal number of vehicles in each lane, the average density in the back-up would be 38' per vehicle, or 139 vehicles per mile in each lane.

Travel Times Measured

Sample travel times were measured for vehicles in queue to travel 800 feet. The average time was 55 seconds (about 10 MPH) as against a normal travel time of about 12 seconds. Therefore, the delay in an 800-foot queue was about 43 seconds per vehicle. The maximum delay occurred for the vehicle that arrived at 5:21 (queue length of 1,700') and it amounted to 92 seconds, or about 1½ minutes. The average delay for each vehicle arriving during the period of queuing would be half the maximum amount (this assumes a uniform queue buildup and disappearance which actually, from Fig. D, was not the case). Since about 900 vehicles arrived during the period of queuing, the total delay was 690 vehicle-minutes.

Fig. E shows a theoretical way of computing this delay which checks the above calculations fairly well. The actual accumulation of output and input vehicles is plotted against time. Delay (vehicle-minutes) is the area between the two curves. The vertical distance between curves represents number of vehicles delayed at any point in time. The maximum is about 80 which is approximately the same as arrived at in the above calculation and occurs at the same time. The horizontal distance between curves represents delay to an individual vehicle. The maximum is about 2 minutes as compared to the calculated maximum of 1½ minutes.

Control Device Book Completely Revised

Copies of the new Manual on Uniform Traffic Control Devices for Streets and Highways are now available and may be purchased for $2 each from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C.

The new manual contains the first complete revision of standards for the design and application of signs, signals and markings since 1948. The revised standards reflect changes in driving conditions and technical advances in control devices and practices in recent years. The publication is expected to spur uniformity and modernization throughout the country.

Nicasio Road

Construction of Dam Requires Relocation of F.A.S. Highway

By ARTHUR T. KNUTSON, Construction Engineer, Marin County

Work was completed on April 25, 1961 for the relocation of the northwesterly 1.4 miles of the San Geronimo-Nicasio Road in Marin County, the last step in providing a traversable road to replace portions of the Marin County Road System inundated by construction of the Nicasio reservoir.

The San Geronimo-Nicasio Road is a portion of Marin County Federal-aid Secondary Route 1278, which begins at U. S. Highway 101 three miles north of San Rafael, proceeds westerly along Lucas Valley Road for 10.9 miles to the San Geronimo-Nicasio Road, thence northerly through the historic old town of Nicasio and terminates at the Point Reyes-Petaluma Road 5.3 miles from Point Reyes. This road furnishes an alternate route from U. S. Highway 101 to Point Reyes with little interference from local traffic. Traffic using this portion of the route is a combination of heavy-truck traffic from Point Reyes and San Geronimo, local traffic and week-end recreationers. Present Average Daily Traffic is 570 with an expected ADT of 1300 by 1980.

In November, 1959, the Marin County Board of Supervisors entered into an agreement with the Marin Municipal Water District for the relocation of 4.7 miles of roads which were expected to be inundated by the construction of an earth fill dam on Nicasio Creek 5 miles from Point Reyes.

Agreement Reached

The agreement was reached after extensive legal proceedings in which the water district attempted to condemn the county roads. The Superior Court and the District Court of Appeal ruled in favor of the water district. The case was then appealed to the State Supreme Court, which ruled that county roads and rights of way are owned by the people of the State of California and are held in trust for them by the county.*

* The attorneys for the State Department of Public Works filed an amicus curiae (friend of the court) brief in support of the position of the County of Marin.

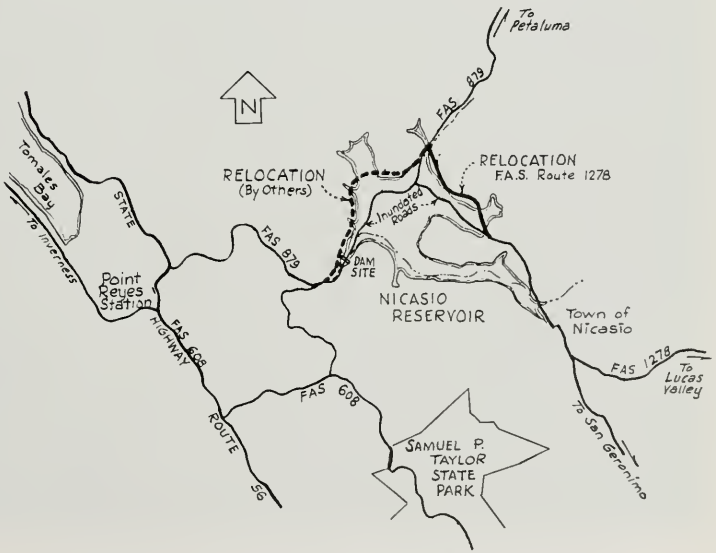
The Supreme Court held (*County of Marin* v. *Superior Court*, 53 Cal. 2d 633; 2 Cal. Rptr. 758) that the county roads could not be condemned by the water district because of the provisions of Code of Civil Procedure Sections 1240.3 and 1241.3, which provide that "property appropriated to the use of any county . . . may not be taken by any . . . water district, while such property is so appropriated and used . . ." The Supreme Court also stated that the Legislature has forbidden the condemnation of F.A.S. roads by the State's assent to the provisions of the Federal Highway Act. Projects such as these must be accomplished by a mutual agreement to relocate affected roads to acceptable standards of design and construction.

Increasing Demand

In order to meet the increasing demand for water, the Water District had been counting on use of the Nicasio Reservoir to collect the 1960-61 rainfall. As water contained in Water District facilities was reaching a dangerously low level and legal action had delayed start of construction on the relocated roadways, it was imperative to complete the relocations at a date as early as possible, to enable full use of the new reservoir.

The project was divided into two portions: A 3.3 mile relocation of the Point Reyes-Petaluma Road to be contracted out by the Water District and under inspection and control of the Marin County Department of Public Works, and the 1.4 mile portion of the San Geronimo-Nicasio Road from the newly relocated Point Reyes-Petaluma Road southeasterly toward the town of Nicasio to be handled as a Federal-aid Secondary project by Marin County.

The Point Reyes-Petaluma portion of the relocation involved cuts up to 155 feet and submerged fills up to 65 feet with 760,000 cubic yards of excavation. The contract was awarded to Cherf-Sandkay & Cheney; work began on May 1, 1960 and paving was completed on November 1, 1960.



The dotted line in the above map shows the Nicasio Road relocation discussed in this article.

Seattle Public Library
SEP 5 1961

Plans for the San Geronimo-Nicasio portion of the project, FAS 1278(3), were prepared by County. This project was advertised by the State and the contract was awarded to W. H. Stecker of Burbank. Work commenced on August 8, 1960.

Grading Completed

Mass grading was completed prior to the first rains, which fortunately were extremely late. However, placing of select material and aggregate base were completed between rains.

Several construction difficulties arose. One problem was caused by a 70 foot cut through Franciscan sandstone interbedded with black shale, which, upon excavation, showed bedding planes with a dip of approximately 1¾ to 1 and a strike parallel to roadway centerline. The design cut slope was 1:1, with one 20-foot bench at 40 feet above profile grade, resulting in a number of slides of a block nature. It is intended to overcome this difficulty, when of a block nature. It is intended to overcome this difficulty, when the roadway is widened to 4 lanes, by utilizing 2:1 cut slopes at this location.

Another difficulty was the use of local, creek-run sand and gravel deposit of marginal quality for the production of Class 2 Aggregate Base material. The source of material had been used in the past and it was known to have marginal Sand Equivalent and "R" values. The special provisions were written to require a Sand Equivalent of 35 by which it was hoped either to discourage the use of the marginal material or to require the installation of washing facilities. The contractor elected to use the marginal material, crushing and washing it. The material proved to be of lower quality than the contractor expected, and 3,910 tons of the aggregate base material as delivered to the grade were below specification in regard to Sand Equivalent and marginal in regard to "R" value. This problem was resolved by the contractor adding sufficient Portland cement at his own expense to correct this deficiency. The cement was placed with a spreader at the rate of one percent by weight of the aggregate and mixed with three passes of a mixer.

Road Inundated

After the existing road was inundated in February 1961, traffic was



An easterly view of the Nicasio Road relocation, an F.A.S. project. The old highway will be inundated when the reservoir behind Nicasio Dam is at its highest level.



A northerly view of the Marin Water District's Nicasio Dam and rerouted section of Nicasio Road (FAS Route 879). The reservoir behind the dam is not yet full.

routed through the new construction which had received the first lift of aggregate base. With the approach of drying spring weather paving of the project was commenced on March 31, and continued to completion on April 25.

The project was designed on a 142 foot minimum right-of-way with limited access, providing for an ultimate 4-lane divided freeway. A design speed of 60 M.P.H. was used, and initial construction provided two 12-foot travel lanes and two 8-foot shoulders on a 40-foot all paved section. Portions of the road lying on submerged fills required special attention to drainage facilities and slope protection for wave action.

Net contract payment was $242,-619.98. Federal-aid Secondary and State Highway Matching Funds totaling $100,000 were used; and the remainder was contributed by the Marin Municipal Water District.

The design and construction engineering was performed by the County of Marin, under the direction of Marvin W. Brigham, Director of Public Works. Construction was performed by W. H. Stecker, with Phil Oppenheimer, Superintendent; and the riprap, base, and paving were subcontracted by E. A. Forde Company with Orville Cooper, Superintendent. James F. Wiese of Marin County was Resident Engineer.

S.M.-H. Bridge Section Will Be Four-Laned

The State Department of Public Works has awarded a $13,278,590 contract for construction of 4.5 miles of four-lane concrete trestle to replace the easterly portion of the present two-lane San Mateo-Hayward Bridge.

The trestle will traverse the nonnavigable portion of San Francisco Bay and will be at the same height above the water as the present trestle and immediately adjacent to it along the north side.

Plans call for construction of a two-lane trestle along the north side of the present structure.

James Robert Smith

James Robert Smith, 37, Senior Right-of-Way Agent for the State Division of Highways in Sacramento, was drowned on June 9th while on a fishing trip in the Blue Hole area of Salt Springs Reservoir on the Mokelumne River.



James Robert Smith

Smith was Chief Analyst of the Division's Land Economic Studies Section. Readers of *California Highways and Public Works* know him as the author of several recent articles on the effect of freeways on adjacent lands.

He was national secretary of the Land Economic Studies Committee of the American Right-of-Way Association.

A native of Pittsburgh, Pennsylvania, Smith attended grade and high school in San Diego, California, and graduated cum laude from San Diego State College.

Smith joined the State as a Research Assistant with the Department of Finance in 1949 and became a Junior Right-of-Way Agent with the Division of Highways in 1950 in the San Diego office.

He transferred to Sacramento as Chief Analyst of the Land Economic Studies Section in 1957.

Smith served as an aerial gunner with the U.S. Air Force during World War II.

He is survived by his wife, Anna, daughter, Susan and his mother, sister and two brothers.

Smith was a member of the Commonwealth Club.

Maintenance in VII

District's Program Grows to Meet Needs

By W. D. SEDGWICK, Assistant District Engineer



THE District VII Maintenance Department, as of December 31, 1960, had 23 regular maintenance crews, 17 landscape maintenance crews, 2 fence repair crews, 3 tree crews, a trash collection crew, a bridge crew, a signal and safety lighting crew, a sign crew, and a striping and stencil crew and an electrician to maintain underpass drainage pumps.

The maintenance program is shifting continually from normal maintenance experiences on conventional highways to new freeways, most of which are either planted for erosion control or are fully landscaped.

Total expenditures by maintenance forces or of maintenance funds during the 1959-60 fiscal year were as follows:

General Maintenance	$1,910,643
Storm Damage and Specific Maintenance Work Orders	3,025,313
Maintenance Fund Contracts	12,867
Total Maintenance Funds by Maintenance Forces	$4,948,823
Maintenance Expenditures by Other Than Maintenance Forces	95,841
Maintenance Expenditure by Cities	864,881
Total Maintenance Funds Expended	$5,909,545
Total Other Than Maintenance Expenditures by Maintenance Forces	948,074
Total Maintenance Department Program Expenditures	$6,857,619

Maintenance problems vary from near desert conditions in Antelope Valley to snow removal up to 8,000-foot levels on the Angeles Crest Highway, and from traffic volumes of from 110 cars a day on Decker Canyon Road to between 175,000 and 200,000 cars a day on the Hollywood and Harbor Freeways. With traffic requiring all the lanes at all times during the normal work week, several maintenance items such as striping and patching bridge abutment settlements have to be accomplished on Sunday mornings between daylight and church time.

One of the maintenance operations which indicates an appreciable change is that involving loss reports. There are so many more light standards, miles of guard rail, signs and signals to knock down that the increase is continuous as indicated by the following tabulation:

Fiscal Year	*Total Cost of Repairs*	*Costs Collected or Collectible*	*Costs at State Expense*
1955-56	$155,346	$96,654 (62%)	$58,692
1956-57	167,971	110,949 (66%)	57,022
1957-58	167,800	107,582 (64%)	60,218
1958-59	220,493	147,441 (67%)	73,052
1959-60	255,281	167,913 (66%)	87,368

There were only 28 chain link divider loss reports during the period July, 1959 to July, 1960 which amounted to a total cost of $3,670. Since that time additional miles of fence have been placed, and the District now has approximately 12 miles of chain link divider fence. Two fence crews are employed full time repairing these fences and request has been made for additional personnel in order to keep up with the damages. The length of chain link divider will increase appreciably in the very near

Author Retires After 32 Years of State Service

William D. Sedgwick, Assistant District Engineer of District VII, State Division of Highways, in Los Angeles, retired in July after 32 years with the State.

He was in charge of the maintenance of all State highways in Los Angeles, Orange and Ventura Counties, an area which includes a major portion of California's freeways. He was the developer of a vacuum trash collector which has greatly facilitated roadside cleanup.


W. D. Sedgwick

Sedgwick joined the Division in Sacramento as an office assistant on Federal aid projects in 1929. Prior to that time he had been employed by the U.S. Bureau of Public Roads.

From 1930 to 1932 he was resident engineer on several highway jobs in Central California after which he was appointed Assistant Maintenance Engineer in District X, Stockton.

Sedgwick served with the U.S. Navy Civil Engineers Corps during World War II and was stationed in the American and Pacific Theaters. He left active service with the rank of Commander in 1946 to return to the Division of Highways as Maintenance Engineer in District 1, Eureka. In 1949 he was transferred to District VII to head the maintenance program there.

A native of Manitowoc, Wisconsin, he attended grade and high school in Creswall, Oregon. He holds degrees in electrical and civil engineering from Oregon State University.

He is a member of Sigma Tau engineering fraternity, the American Society of Civil Engineers and the American Public Works Association. He was promoted to Captain in the U.S. Naval Reserve in 1955.

Following retirement, Sedgwick and his wife plan a European tour during which they will visit their son, Clyde, a first lieutenant with the U.S. Forces in Germany.



Slide Removal Operations. A bulldozer gathers the loose rock into piles.

future, as there is a total of 77 more miles of chain link divider fence that is either under construction or budgeted for construction. Doubtlessly, these fences have saved many lives; however, the repair and replacement of damaged fence has increased the work load of maintenance forces.

Annual repair costs of guard rail including cleaning, painting, non-loss and accident loss items amounted to $120,200 in 1958-59 and increased to $140,633 during the 1959-60 fiscal year.

The sign situation is also an indication of increased requirements as a comparison between fiscal years will bear out. In fiscal 1955-56 new sign installations and general maintenance numbered 30,901 individual items. In fiscal 1959-60 this number rose to 39,007.

Striping, Pavement Markings

Besides taking care of the necessary restriping and pavement markings on old pavements, maintenance crews accomplish all the new striping and markings as the various contracts are completed. This requires close coordination with the resident engineers in order to have the temporary and final striping done just prior to opening each new section to traffic. Besides the new construction, new stripes have to be placed on the resurfaced portions each year under the light surface treatment program.

The sign and striping program by expenditures increased 18.63% from $612,571 in 1958-59 to $726,693 in 1959-60.

Signals and Lighting

Although one might think that the replacement of conventional highways with freeways would reduce the work to be done by maintenance crews, the following tabulation indicates otherwise.

This program, on the basis of expenditures, went up to 12.22% from $808,380 in 1958-59 to $907,203 in 1959-60.

Sweeping, Trash Pickup

Cleanup problems are on the increase in District VII. With nearly 15% of maintenance man years given to this task, it becomes a major opera-

	1956	*1957*	*1958*	*1959*	*1960*
Illuminated Signs	312	333	445	488	585
Fluorescent Tubes for Above Signs	1,716	1,832	2,448	2,684	3,180
Safety Lighting Fixtures	4,650	4,895	5,373	5,690	6,743
Fixed Time Controllers	372	381	379	356	358
Signalized Intersections	691	741	752	760	798
Traffic Actuated Controllers	319	360	373	404	440



Slide Removal Operation. The rock is then loaded into trucks for removal from the site.



A highway maintenance crew removes debris from an overturned truck on a freeway.



The vacuum trash collector of the type developed by the author is shown in operation.

tion. Combined cost totals for State and city maintained State Highways during two sample budgetary years stress the seriousness of the litter problem. During 1955-56 $661,024 was spent, during 1959-60, $723,079, with indications that these totals will rise in succeeding years.

Maintenance Personnel

In order to take care of the rapidly moving freeway program, as conventional highways are being replaced by these new landscaped facilities, there is continual need for a greater labor force. Maintenance personnel in 1955-56 totaled 393, in 1959-60 the total was 578. It is anticipated that a corresponding percent increase in personnel requirements will continue through the coming fiscal year and extend at least into the 1962-3 fiscal year.

Oiling Program

The District VII allotment of maintenance oiling program funds was $133,350. This work was started by Maintenance forces in July soon after the completion of the last annual traffic census. The program consisted of emulsion slurry seals, sand seals and flush seals using SC-2 liquid asphalt, heater planer removal of excessive asphalt and corrugations from asphalt concrete pavements, reprocessing road mixed asphaltic pavements and extensive patching.

The District's recommendations for the 1961-62 fiscal year thin blanket and deferred seal coat program, which were prepared by the Maintenance Department last summer, have been approved by the California Highway Commission for a total of $518,400. This program, which is principally made up of 1-inch asphalt concrete blankets or resurfacing, contributes in a great measure to the high standard of condition of our asphaltic pavements as well as to reduction in the amount of traveled way patching.

Bridges

The maintenance of bridges, underpass pumping plants, maintenance buildings and facilities is also big business.

The cost of maintenance and repairs to some 1,200 bridge structures last year was in the neighborhood of

$40,000. During the past year an electrician was added as full time attendant for preventive electrical maintenance for the pumps on 33 underpasses. These pumping plants represent an investment of $1,000,000.

Maintenance Stations

The cost of maintenance and repairs to 40 permanent maintenance establishments was about $25,000. Thirty-one of these permanent facility locations are used directly in conjunction with normal highway maintenance while nine are for the landscaping crews in the metropolitan area. In addition to these permanent facilities there are four on temporary basis and two landscape facilities that are leased. Two landscape facilities which are presently under construction will release one of the leased facilities.

The cost of expanding existing stations and the addition of one complete new facility will be over $600,000 this year.

The demand for additional winter sports facilities near the Los Angeles metropolitan area is justifying the construction of the $295,000 new maintenance station at Wrightwood so that the Angeles Crest Highway may be reopened as soon as possible after each storm and the roadway kept sanded to keep it safe for traffic.

Maintenance in Cities

A highway maintenance agreement is negotiated with each city having operating State highways within its boundaries. This agreement is a legal document, duly executed by City and State and remains in effect until superseded, amended, or terminated. The agreement defines the terms, the degree, and the scope of maintenance and sets forth the manner in which it shall be performed.

Under the highway maintenance agreement, cities bill the State monthly for the actual cost of work performed on State routes. The bills are reviewed and audited by the Maintenance office before being forwarded to the Accounting Department for scheduling.

Maintenance Equipment

The District VII Maintenance Department presently has 568 pieces of equipment assigned to its operations.



A crew removes a damaged post prior to replacement of a new section of fence.



Members of the maintenance crew tighten up the reinforcing cable in the replaced section of fence.



A maintenance worker fastens a large freeway sign to a post with steel bands.



Following assembly, the crew raises the sign and secures the posts in the ground.

Street light and signal maintenance crews are using 33 units, the landscape personnel have 81 of these units assigned to their operations, signs and striping crews 34, and the other 420 units are standard maintenance equipment. Of these 420 items, there are 93 pieces of snow removal and pavement sanding equipment.

For the 1961-62 fiscal year, 20 additional units will be required for the landscape program, and 16 units will be required for a new maintenance station at Wrightwood.

Communications

The District VII radio and teletype facilities, although an integral part of the Maintenance Department, may be considered as the actual nerve center of the entire District.

Its facilities include eight 2-way land stations, 2 repeater stations, 185 mobile and portable radio units, 3 teletype machines, 3 telephone recording devices, telephones, Sig-alert and Conelrad units and a Micro-wave Radio and Relay System.

The District office communications center now operates on a 24-hour, 7-day a week basis and is staffed by 7 Division of Highways trained radio dispatchers. The outlying land stations are located in the various Highway, Shop and Signal Laboratory offices and are also operated by fully trained highway personnel. The relay stations are situated on surrounding mountain peaks and provide maximum radio coverage for the area.

These facilities are always available to immediately handle all types of emergencies, whether it be slides, accidents, road closures, snow, ice, fires, floods or highway damage of any type.

Permits

Transportation and encroachment permits are issued in accordance with policies that protect the invested rights of the traveling public. This control also restricts encroachment work that would conflict with present facilities or future highway development plans. There are 26 people curently employed in the permit section. Engineering costs for inspecting encroachment permit work is chargeable to the permittee, except for permits issued to other governmental agencies.

'TEMPUS FUGIT' CORNER

The following items appeared in the July 1936 issue of *California Highways and Public Works.*

Contest Winner

The Tower Bridge spanning the Sacramento River at Sacramento won second place in Group B (bridges costing between $250,000 and $1,000,000) in the annual national competition held in New York by the American Institute of Steel Construction, Inc., for the most beautiful bridge built during the past year. * * *

The old bridge, built in 1910 at the same location, had long been an eyesore to the people of the State who entered Sacramento from the west. M Street, the Pennsylvania Avenue of California, runs directly into the State Capitol, which is flanked by the new Capitol Extension buildings and Capitol Park. It was unimpressive to say the least to have such an antiquated structure as the gateway to the beautiful capitol buildings and grounds. When the need for a new bridge became an absolute necessity due to traffic requirements, popular sentiment demanded that every effort be expended to design a structure which would be unexcelled in architectural and engineering beauty and thus conform to its natural setting.

Old Sacramento

Jibboom Street grade separation and bridge approach project in Sacramento, now under construction, is another instance of the cooperation of State, city and Federal government * * *.

The name "Jibboom Street" recalls to old Sacramentans an earlier day when Jibboom Street or Water Street, now a part of the Southern Pacific Railroad yards, fronted on the Sacramento River and provided a place of business for commercial fishermen to tie up their boats and display their wares.

New Format

California Highways and Public Works changed its format from 6½ x 9¾ inches, which size it had been since Nov. 1927, to 8½ x 10¾. Its predecessor, *California Highways* (1924 to Nov. 1927) was 9 x 11, as was the original *Highway Bulletin*, published in five issues between 1912 and 1916.

Drivers to Fair Can See New Road Work

"Pleasure driving" to California's State Fair, held annually in Sacramento, will be especially enjoyable this year due to state highway improvements on traveled roadways and the planting of adjacent highway right-of-way areas.

Visitors to the 1961 California State Fair and Exposition, to be held August 30 through September 10, will find that roadway and landscaping improvements have been made on portions of all of the state highways normally used to reach the capital from all points of the compass.

Drivers taking U.S. 40 from the San Francisco Bay area will travel on freeway and expressway all the way except for two four-lane undivided sections north of Vallejo, and the Yolo Causeway section just west of Sacramento. Work is under way to make the entire route freeway and expressway, and a new Yolo Causeway may be seen under construction to the driver's right as he nears the capital.

On U.S. 50-99 between Stockton and Sacramento, fair visitors will encounter long stretches of freeway complete with planting in varying stages of growth. Construction work may be observed along the Stockton bypass, but it is not anticipated that the work will interfere with normal traffic flow.

En route from Auburn to Sacramento, freeway and expressway speeds may be used throughout, except for a short stretch between Marconi Avenue and Arden Way in Sacramento. In this area new lanes are being added in each direction. The construction area will be marked for reduced speeds.

Between Placerville and Sacramento several sections of new highway will be encountered, but normal freeway and expressway speeds may be maintained since construction work will be over a new alignment.

Visitors from Marysville using State Sign Route 24 will not encounter construction work as improvements on this route have been completed.

Visitors who attended the fair last year will be pleasantly surprised at the progress of the planting along most of the state highways. A special display at the fair will show the various types of planting utilized by the Division of Highways. The display will be located in the outdoor education area opposite the Hall of Flowers.

MAINTENANCE VII

Continued from page 56 . . .

Encroachment and transportation permits of all types issued by the District in 1959-60 amounted to 5,872 and 21,251, respectively.

Landscape Maintenance

The cost of maintaining landscaped areas is primarily pre-determined by the type of planting, the value and use of adjacent property and the type and speed of traffic. A fully landscaped area through the Bel Air section of the San Diego Freeway or the Hollywood Freeway would require a much higher degree of maintenance than would the pasture land adjacent to much of the Long Beach Freeway.

Maintenance methods and costs are dependent upon many conditions. Natural conditions such as climate, soil, grade, proximity to other jobs and types of plant materials, added to man-made conditions such as irrigation systems, chemicals, equipment and mulches all affect maintenance of landscaped areas. Fortified weed oils are being used to control young weeds in areas mass planted to trees and shrubs, thus eliminating costly hand weeding.

A reduction in maintenance costs has resulted from planting native or drought-resistant plants where watering can be reduced or eliminated after several years of tank-truck watering. As plantings mature and accomplish their purpose, maintenance is reduced, and a portion of the personnel is shifted to other jobs.

Sign Vandals Waste Tax Money

Survey of State's Eleven Highway Districts Shows Cost Approximately $300,000 Annually



Directional sign with 39 bullet holes in it had to be replaced after two weeks service at cost to county of $18.37. Such cavalier treatment of all state's signs would require about $50,000,000 annually for maintenance.



One Highway District says of this sign, which had been in place less than two months, and was found with 85 bullet holes in it: "Many of the bullets passed clear through the sign in such a way that they crossed busy Highway 41 from Fresno to Yosemite at a point about 30 feet beyond the end of a high cut. The shooter had to have stood in the position where he could not possibly see traffic approaching this point through the cut. Thus it appears possible, by considering reaction time, that a car could have driven into the line of fire between the time the shooter squeezed the trigger and the time the bullets crossed the road."

In order to get specific information on sign vandalism in California, the State Highway Engineer recently queried all districts in the state on their experience with this problem. The response was very informative, and showed that the cost to the taxpayer of this wanton destruction was even higher than previously had been supposed.

Responses to the questionnaire show that it costs between $275,000 and $325,000 each year to repair or replace official signs destroyed or damaged by vandals. This figure is for state highways alone, and does not include damage to signs on city streets and county roads. (Fresno County, for instance, estimates its costs for vandalism at $10,000 yearly.)

"This senseless destruction of warning, regulatory, and directional signs continues to be a serious problem," State Highway Engineer J. C. Womack said. "Repairs are expensive, and in some cases there have been tragic accidents because a sign was stolen or destroyed."

In 1960 California had about 220,000 signs in its state highway system, costing anywhere from fifteen dollars up to many thousands. About one-sixth of these must be repaired or replaced each year. In the greater Los Angeles area alone eight to ten trucks and crews spend every Monday replacing knockdowns, many of these intentional. This is in line with the findings of the survey which showed the major source of damage in metropolitan areas is smashing and breaking signs with a vehicle. There is also considerable damage from thrown objects, and many instances of deliberate bending of signs have been encountered.

As might be expected, there is less damage from gunshots near cities. Where urban shooting laws are not enforced, however, signs suffer at the hands of marksmen with small calibre weapons and air guns. Even the pellet from an air rifle will destroy the enamel coating on a sign, exposing the metal to rust and eventual deterioration.

RIGHT—Some youths think it sporting to attempt to make pop bottles stick into the larger freeway signs by throwing these missiles from fast moving cars. Repairs are expensive, but misses are worse, for they create broken glass hazard on the roadway or might kill unlucky bystanders. (Fresno Bee photo).



Actual removal or theft of highway signs is common, particularly around college towns. In the same vein, it was almost impossible to keep "Pismo Beach" signs in place when this town was being mentioned on a popular comedy program.

Sometimes epidemics of malicious mischief aimed at highway signs seem to run through juvenile groups. Last year 33 warning and directional signs were removed from U.S. 466 between Paso Robles and the Estrella River. These later were found lying discarded in the Salinas and Estrella Rivers. A more costly series of incidents occurred in the Atascadero vicinity, when many signs were knocked over by vehicles.

There is less damage to signs on freeways, presumably because heavy, fast-moving traffic makes vandalism difficult. One freeway construction project in the Los Angeles area was the scene of several thousand dollars in sign damage, however, when children invaded the right-of-way just before the section was opened to traffic.

Occasionally, signs are removed and hidden by individuals who object to them.

In a ranching area, a stop sign was removed and replaced eight times before a highway superintendent early one morning traced a trail of high-heeled boot tracks through wet grass to a nearby canyon, and found all eight signs.



About $75 is needed to replace this two-past city limit sign carelessly destroyed by "muscle men."

San Joaquin County replaced the stop signs at one intersection 20 times in 18 months. On one instance, not only were the signs removed, but the posts were piled in the middle of the road and burned.

A man in Santa Cruz County was jailed for malicious mischief for removing a stop sign because he got "sick and tired of stopping at that sign 25 times a day" while trucking produce to a packing plant.

At least one fatality can be attributed to the unauthorized removal of a stop sign as a Halloween prank.

In rural and mountain areas heavy damage results from rifle and shotgun blasts, particularly during hunting seasons.

A few years ago maintenance crews installed 16 turn-out signs on a mountain section of Sign Route 168 in Fresno County. The next day 13 of these signs had to be replaced because of gunshot damage.

One sign in a desert area was blasted to useless wreckage by a shotgun 30 minutes after it had been installed—a half-hour life for a $15 sign.

Some target shooters aim at signs from moving cars. Highway maintenance superintendents reported that a single car will sometimes pass through an area and leave up to 35 shooting-damaged signs.

Reconstruction of the line of fire often shows the bullets from a high-powered rifle passed across the highway, in such a way that occupants of vehicles rounding a curve or coming over a rise would be seriously endangered. At other times buildings in the vicinity were in the line of fire.

In one highway district the sign foreman found a sign badly shot up near a rural store. The angle of the bullet holes through the sign indicated that it could only have been shot at from the porch of that store. Nevertheless, the proprietor disclaimed any knowledge of the shooting, and even said he had never heard any gunshots, although he lived in the back of the store. He was told the seriousness of damaging signs and that particular sign has never been damaged again.

Although damage from gunfire is more common in rural areas, other malicious acts are also committed.



One district's accumulation over a few months period of shot-up, bent, and smashed signs.

Vandals throw rocks at signs or deliberately ram them with vehicles. Outright theft is frequently reported. "Show-offs" and "muscle men" prove their virility by bending metal signs with their hands.

Most citizens are surprised to learn the expense of highway signs and their maintenance. When travel to the site and labor is considered, the simplest sign repair costs at least $5. When major repairs must be made, or signs must be replaced, the cost is anywhere from $15 to $400 for the smaller signs. (The big signs on the freeways may cost as much as $20,000, but vandals rarely can get to them).

Willful destruction of highway signs in California is a misdemeanor punishable by a maximum $500 fine, six months in jail, or both. An increasing number of judges are meting out strict punishments to violators. The Shasta County supervisors in 1960 passed a resolution offering a $200 reward for information leading to the conviction of anyone who maliciously destroys any public road appurtenance in that county.

When three boys in the San Joaquin Valley were caught vandalizing and removing highway signs a rural justice of the peace sentenced them to repair all the damaged highway signs on a fifty mile stretch of road. They labored three full days under a hot August sun carrying out the sentence.

Some authorities feel the answer to the problem is strict punishment such as this whenever possible, others feel education is what is needed to stop this practice which, in effect, wastes the gasoline tax paid by many thousands of California drivers each year.

Three Long-Time Architecture Employees Retire

Three veteran employees of the State Division of Architecture retired during June and July. They are Ernest Aeppli, senior structural engineer in Sacramento with 31 years' state service; Robert C. Younger, senior architect and assistant to Assistant State Architect A. F. Dudman in Sacramento, 25 years; and H. E. J. "Woody" Woodhams, district construction supervisor in Los Angeles, 39 years.



Ernest Aeppli

Aeppli joined the Division in 1929. Two years later he transferred to the Bridge Department of the Division of Highways.



Robert C. Younger

Aeppli designed the first concrete box girder bridge constructed by the State of California. He was also the first to design a light-weight box girder frame bridge with counter-weighted abutments.

During World War II Aeppli was senior bridge engineer on construction of the Alaskan Highway and was awarded a certificate of merit for his services.



H. E. J. Woodhoms

In 1947, he returned to the State Division of Architecture as a senior structural engineer. He handled the structural design of the division's first thin shell structure, the flower show exhibit building at the Santa Barbara County fairgrounds.

A native of Switzerland, Aeppli is a civil engineering graduate of the Swiss Federal Polytechnic Institute of Engineering in Zurich. He came to the United States in 1921 and until 1929 worked for various consulting engineers and architects in San Francisco.

Aeppli and his wife, the former Hedy Klee of Zürich, have two daughters and four grandchildren.

Younger first came to work for the Division of Architecture in 1925 as an architectural draftsman. He left state service in 1936 to work for several private architectural firms in the San Francisco area.

During the early years of World War II he was an instructor in drafting and mathematics at Cal Poly in San Luis Obispo. Afterwards he was in private practice in San Carlos and Redwood City.

He returned to the Division of Architecture in 1950 and shortly afterward was appointed as assistant to Dudman to aid with the coordination of design functions.

Younger was born in Sacramento where he attended grade and high school. He graduated from the University of California at Berkeley in 1924.

Younger is a World War I veteran, having served in the Signal Corps from 1917 to 1919.

Younger and his wife, Margaret, have two daughters and a son and three grandchildren.

Woodhams started work with the Division in 1922 in the Sacramento area. Subsequent assignments as inspector took him to many parts of the State including Los Angeles in 1926, Chico State College in 1927, Napa in 1929, San Quentin in 1933, Whittier in 1934 and San Diego in 1938. Between 1939 to 1955 he was stationed in Camarillo, Tehachapi and Bishop. He transferred to Los Angeles in 1955. His assignment for the past three years has been as construction supervisor on State Building #2 which houses the Los Angeles Office of the Division of Architecture.

Woodhams was born in Livingston, Montana, and went to grade and high school in Los Angeles. He received his B.A. degree in architecture from the University of California at Berkeley in 1922.

Woodhams is a veteran of World War I.

Maintenance Expert Paul Harris Retires

Paul M. Harris, assistant chief of the District VII Maintenance Department, State Division of Highways, in Los Angeles, retired in July after 31 years of state service.

Harris joined the Division in 1930 as a member of a survey party in the Mother Lode area of District X. He worked on construction projects in District V (San Luis Obispo) and District IX (Bishop) from 1931 to 1932, after which he was transferred to District VII.



P. M. Harris

From 1934 to 1940 he was in charge of asphalt concrete plants in District VII after which he was appointed Assistant Maintenance Superintendent at Santa Monica.

During World War II he served as a captain in the U.S. Army Corps of Engineers.

He returned to the Division in 1946 and was promoted to Assistant District Maintenance Engineer in 1948. He was named Maintenance Engineer in charge of administration for the District VII in 1956.

Harris was born in St. Ignace, Michigan. He attended grade school there, high school in Oceanside, California, and holds a degree in mining engineering from the University of Arizona.

Between 1926 and 1930, when he joined the State, he served successively as a private mining engineer, Assistant City Engineer of Oceanside and Assistant Surveyor of San Diego County.

He is a member of the American Public Works Association, the American Society for Metals and a charter member of the California State Employees Association.

Following retirement, Harris plans to work as a private consultant on mining and water development projects.

He and his wife, Lucy, have a daughter, Diane.

Excavation work will start soon on the Caldecott (Broadway) Tunnel on Sign Route 24 in Oakland.

Bond Issue

Final Payment Made on State's 1909 Road Bonds

In 1909 the California Legislature authorized, and in 1910 the people approved at the polls, a bond issue of $18,000,000 for a trunk line system of State highways. It was the first of three such bond issues (the others were initiated in 1915 and 1919) constituting the principal means of State highway financing prior to the enactment of a gasoline tax in 1923.

On July 1, 1961, the State Controller made the final semiannual payment, consisting of $400,000 on the principal and $8,000 in interest, on the 1909 State Highways Act.

The total interest paid on the $18,000,000 bond issue, according to Controller Alan Cranston, has amounted to $18,204,200.

Source of Funds

Source of the funds for redemption of the bonds and payment of interest was, at first, the State General Fund; except that between 1915 and 1920 the interest payments were charged to the respective counties on the basis of the highway expenditures within their boundaries.

Since 1935, the bond issue repayment money has come from the Motor Vehicle License Fee Fund. This is the fund fed by the "in lieu" ad valorem tax on motor vehicles, paid annually at the time of registration or renewal. Except for a small amount for expenses of administration and the redemption of the old highway bonds, this fund is divided between the cities and counties of California and is made available for their use in the same manner as locally collected taxes.

The first bond issue had its political and financial vicissitudes, but it survived them all and paved the way for more popular bond issues in succeeding years.

Majority Was Slight

To begin with, despite a conscientious campaign to "get California out of the mud"—featuring photographs of cars mired to the running boards on rural roads—the bond issue mustered only slight majority at the polls. The statewide vote was 93,297 in favor and 80,509 against. In Los Angeles County the bond issue was voted down by three to one, but it carried in San Francisco by about the same margin.

The $18,000,000 bond issue, bearing 4 percent interest, also proved hard to market. Only $4,280,000 in bonds were sold publicly. The remainder, $13,720,000 was sold to the counties. The counties purchased them, in the words of the Highway Commission's First Biennial Report (1918), "because otherwise the work could not have gone on".



U.S. 50 in the High Sierra near the base of Lavers Leap. The time: 1912.

The 1917-1918 Biennial Report shows that 1,263 miles of State highways had work accomplished on them by June 30, 1916, including about 323 miles graded but not yet paved.

The State Department of Public Works has awarded a $538,000 contract for construction of a new bridge over Tunitas Creek on State Sign Route 1 south of Half Moon Bay in San Mateo County.

Freeway Routes

Sacramento, Bay Area Locations Approved

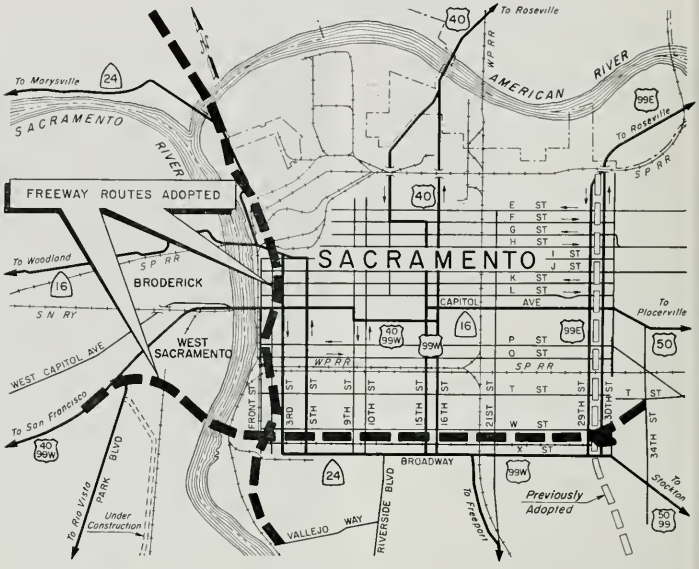
Freeway route problems of long standing were resolved by the California Highway Commission in May and June with the adoption of freeway routes in Sacramento and in the Hayward-Union City-Fremont area of Alameda County. The Commission also adopted a routing for a portion of a new freeway in Contra Costa County which will eventually extend from Sign Route 24 near Walnut Creek to Sign Route 4-24 near Pittsburg.

Sacramento County

The Sacramento routes are for the east-west and north-south freeways in and adjacent to the city. They were recommended by State Highway Engineer J. C. Womack and coincide with the recommendations of a City of Sacramento core area study report.

The route for the east-west freeway extends 3.9 miles between U.S. Highway 40 at Westacre Road in Yolo County and 34th Street in Sacramento. It crosses the Sacramento River in the vicinity of W Street and runs between W and X Streets to 29th and 30th Streets, where there will be an interchange with a previously adopted freeway route connecting the South Sacramento and Elvas freeways. It then swings northerly to 34th Street in the vicinity of T Street.

The north-south freeway route is 16.7 miles long between Vallejo Way near the Sacramento River and the Sacramento River at Elkhorn Ferry, where it connects with a previously adopted route for the Westside Freeway extending to Woodland.



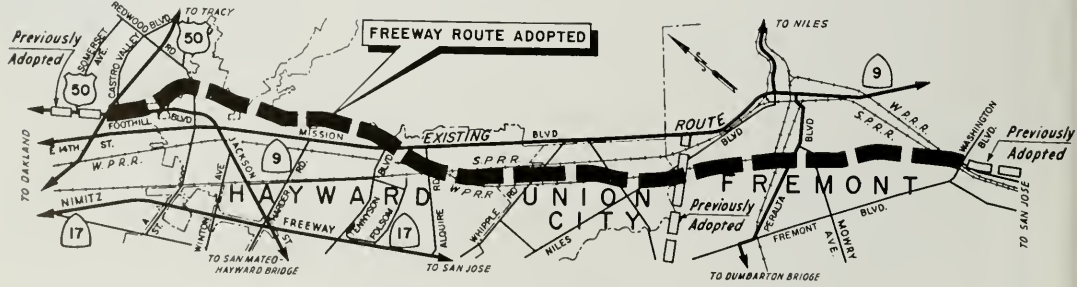
A public hearing on the Sacramento area routings was waived by the City Council of Sacramento and the Sacramento and Yolo County Boards of Supervisors.

Alameda County

The route in Alameda County, adopted after more than two months of follow-up study after a public hearing by the Commission in Hayward, will provide for 14 miles of freeway on Sign Route 9 through the Hayward-Union City-Fremont area.

The adopted route in general is that recommended by Womack, with the major exception of the portion through South Hayward and Union City. In this area the Commission adopted a line near the Southern Pacific and Western Pacific Railroad lines, rather than the line recommended by Womack, which would have traversed the Dry Creek Ranch property which has been offered by its owners as a regional park.

The Commission indicated its preference for the route between the tracks was based not only on preserving the proposed regional park but

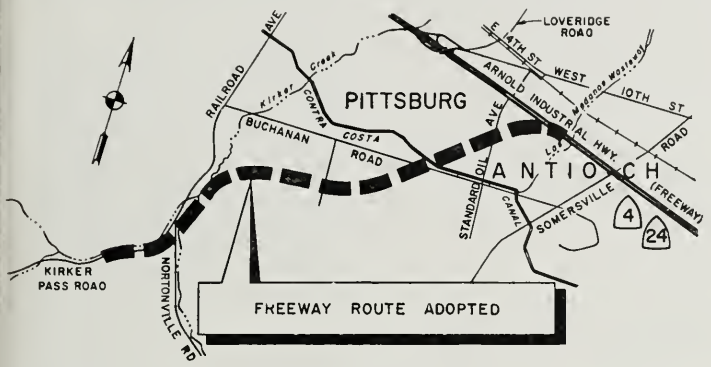


also on better local traffic service and other factors.

Contra Costa County

The Contra Costa County routing is the first section of State Highway Route 256 to be studied for location and adopted as a freeway. This route, none of which has been constructed, was adopted by the Legislature in 1959 and will connect Sign Route 24 near Walnut Creek and Sign Route 4-24 near Pittsburg.

The adopted route extends easterly from Kirker Pass Road west of Nortonville Road to Sign Route 4-24 (Arnold Industrial Highway) just west of the Los Medanos Wasteway. It is 4.2 miles in length.



Construction Costs Rise in 2nd Quarter

An upturn in the California Highway Construction Cost Index took place during the second quarter of 1961. The index now stands at 252.8, an increase of 23.2 points or 10.1 percent over the first quarter of 1961.

The higher index reflects increases in materials and wages which have occurred in the construction industry, and is also affected by projects in California's mountainous areas, where difficult conditions tend to increase price averages. A project on U.S. 40 in the Sierra Nevada Mountains and another project in Kern County in the Tehachapi Mountains were bid at higher-than-average prices.

The number of bidders per project during the second quarter dropped from 6.1 to 5.3.

HIGHWAYS ACCOUNTING PERSONNEL STUDY NEW DATA SYSTEM



Headquarters and district accounting personnel met in Sacramento recently for final briefing and discussion of the accounting procedures which went into effect July 1, 1961. The agenda covered the conversion from the previous accounting system to an automatic data processing system. Included was a tour of Headquarters' Data Processing Center. In the above photo, Andrew Schoellkopf, Assistant Comptroller, Department of Public Works (extreme right) explains some of the new electronic equipment to (front row, left to right): N. Christopulos, District VII; Don Willioms, Headquarters Office; W. J. Reilly, District X; W. J. Elliott, Jr., District XI; C. C. Waterman, District VIII; Ben Stebbins, District I; Mrs. M. P. Mayerle, District IX; (second row), C. West, Toll Bridges; Paul Cowgill, District IV; Robert Mihills, District V; J. P. Willioms, District II; O. Soennichsen, District VI; Tom Akins, Bridge Department; and Roy Rusk, District III.

Talking About Highways — *Comments from Here and There*

The following quotes and comments about highways appeared recently in various California newspapers or were taken from other sources:

Feared Freeways—Now Cheers Them

Los Angeles Times reporter Art Ryon recently looked into the effects of freeways on various Southern California communities and came to this conclusion:

"They have been a boon to almost everyone."

Ryon talked to officials and business leaders in cities where freeways have been built.

"From Ventura Boulevard in Studio City, from El Monte, from Buena Park, from Santa Ana, from San Clemente, from Carlsbad and Oceanside, from Camarillo, and from Gorman high on the Ridge Route, the report is the same:

" 'We were worried about the freeway at first, but now we're thankful they put it through.' "

* * *

El Monte

"El Monte was notoriously stubborn about the San Bernardino Freeway slicing through its boundaries. . . . By various legal processes, it actually held up completion of the freeway—which it called a 'Chinese Wall'—for several years.

"So what has happened?

"In the year immediately after the freeway construction in 1956, new building valuation tripled . . ., population increased 18.5 per cent in two years, and although traffic on Garvey and Valley Boulevards dropped 36 per cent, business establishments on those by-passed highways—stores, cafes, bars and even service stations—all showed a marked increase in business."

* * *

Studio City

"Gerry Gillard, president of the Studio City Chamber of Commerce and owner of a children's shop on Ventura Boulevard, 'by-passed' by the Ventura Freeway, put it succinctly:

" 'As far as traffic is concerned, the boulevard is nothing like it used to be. This has hurt some service stations and motels—but not much. However, it has helped the shops and the fact that business is good is evident from the fact that there is a lot of new commercial building out here.

" 'No more trucks. And customers can find a place to park. As far as my store is concerned, people used to order by telephone, and we had to deliver. Now, they come to the store.' "

* * *

Buena Park

E. F. Bernard, manager of the Buena Park Chamber of Commerce, felt that the Santa Ana Freeway through the city has "solidified" the community.

" 'Some people on the old highway were hurt,' he says, 'but most of them moved to new locations. The freeway, which we feel is an asset, caused a great increase in population, and as a result the established business houses . . . are doing more business than they ever did. And we are getting two large new shopping centers which, I am sure, would never have been located here if it were not for the freeway.' "

* * *

Santa Ana

" 'Our statistics show,' reports Frank Gelinas, manager of the Santa Ana Chamber of Commerce, 'that 46 per cent of the retail business here comes from at least 20 miles away. That is because of the freeway—or because the freeway has relieved congestion on the secondary highways.' "

* * *

San Clemente

Mrs. Jean Stivers of the San Clemente Chamber of Commerce said that they were "scared" about the recently completed freeway bypassing the community.

" 'But—and this is a funny thing—the freeway is up above, and it gives people a wonderful view of our pretty little town and, as a result, we actually are having more foot traffic into the Chamber of Commerce by people asking questions about San Clemente than we've ever had before.' "

* * *

Camarillo

"Although U.S. 101 used to be that community's main street, the bisecting freeway has caused property values to go up and 29 new commercial structures have been built along the old highway, now readily accessible to residents of the community and surrounding areas. Gross retail sales in Camarillo since the freeway have increased 5.66 per cent compared to the average increase throughout Ventura County of 4.86 per cent."

* * *

Summing Up

Ryon quoted J. A. Mellen, planning director of the City of Glendale, in summing up his findings:

" 'I know of no instance,' Mellen declared, 'where the community has not benefited economically from the finally constructed freeway alignment . . .' "

* * *

Wonder of California

From an editorial in the *Santa Monica Evening Outlook:*

"The building of the Los Angeles Freeway System has been necessarily slow because of the enormous difficulties and costs involved. Consequently, existing freeways have become overloaded and people with little knowledge of the program have hastily concluded that the State Highway Engineers and the Highway Commission are fighting a losing battle in building freeways. Especially critics from other parts of the country have delighted in talking about the terrible traffic conditions in Los Angeles . . .

"The facts provide an eloquent answer to those ill-informed critics. One fact is that even with our Los Angeles Freeway System only partly completed, we do a better job in this county of moving great volumes of traffic than is done in almost any other

THE READER SURVEY—A THANK YOU FROM THE EDITOR

During May, 1961, the State Highway Engineer asked the California recipients of *California Highways and Public Works* (exclusive of Department of Public Works employees) for their reaction to a proposal to establish a subscription charge for this publication. The proposal was contained in a Concurrent Resolution previously adopted by the State Assembly and at that time under consideration by the Committee on Transportation of the State Senate. The survey was made at the request of the Committee on Transportation.

The response to the survey was gratifyingly prompt and heavy. Approximately 60 percent of those who receive a publication by mail returned the survey postcards. While a great many people indicated a willingness to pay, it was nevertheless evident that there would have been a substantial reduction in circulation if a charge were established.

On June 13, the Senate Committee on Transportation declined to take favorable action on the resolution.

The survey was of considerable value. The cooperation and interest of the majority of readers who responded so promptly and in such large numbers was deeply appreciated. The comments written on the postcards were helpful, as were the letters which quite a few readers took the trouble to write—practically all of them constructive in approach. And it was of course gratifying to receive a substantial expression of willingness to pay a subscription charge for an official journal which has historically been available free of charge to interested persons.

The pattern of reader interest revealed by the survey was in general one of the citizen and taxpayer desirous of keeping informed on statewide highway progress and on the use being made of his tax dollars. There were a few suggestions for changes in content; but the prevailing attitude appeared to be in favor of the publication's long-established policy of carrying both technical and general-interest articles.

In summary: there is no further consideration being given at the moment to establishing a subscription charge for *California Highways and Public Works;* and the Division of Highways is most grateful to readers on the mailing list for their cooperation.

L. S. K.

Talking About Highways

Continued from page 66 . . .

metropolitan area in the world. And the second fact is that when the entire freeway network is completed . . . , freeway driving time will be materially reduced throughout the entire area.

"In the not distant future our metropolitan system of freeways will be recognized as one of the wonders of California and as a model for other big metropolitan areas whose motorists would also prefer to drive their own cars to and from their work if they could."

Banning Freeway Warry Unfaunded

Reporting in the *Palm Springs Desert Sun*, Ken Reich wrote of new prosperity in Banning as a result of the freeway there:

" 'Banning didn't start to grow until that freeway went in. The freeway has been a wonderful blessing.'

"So spoke Mrs. Lena Klein, head of the Banning Board of Realtors. Residents of the Pass city weren't always talking that way.

"When the freeway carrying (U.S.) 60-70-99 traffic around the city opened July 1, 1955, there was considerable uneasiness in Banning and some were quick to predict that its days of prosperity were over.

"Now, six years later it is evident they are only beginning."

Reich reported that community leaders inaugurated a "smooth-running coordinated operation" to attract new business and industry. This campaign has met with success. The city's population has increased. Even motels along the old highway "are now doing as much business as ever."

"In short," Reich concluded, "Banning is prosperous and confident of the future, which is a far cry from the pessimism of 1955."

Right-of-Way Agent Edward King Retires

Edward F. King, Senior Right-of-Way Agent for the California Division of Highways in Los Angeles, retired on July 10 after 23 years of State service.



Edward F. King

King was in charge of right-of-way acquisition in the west half of Los Angeles County and all of Ventura County where some 10 million dollars worth of property for highway and freeway construction is bought annually.

King was born in Omaha, Nebraska, where he attended grade and high schools. He also holds a degree from Loyola University of Law in Los Angeles.

King was in private land acquisition and development in Nebraska, Montana and Califoria until 1929 when he went to work for the City of Los Angeles doing land appraisal and right-of-way work. He joined the Division of Highways in 1938.

King served in the U.S. Navy during World War I.

He is a member of the American Legion and the Los Angeles Athletic Club and is a charter member of the American Right-of-Way Association in Los Angeles and charter member and first president of Chapter 101 of the California State Employees Association.

King plans to tour Europe after which he will devote his time to golf and developing some mining claims and properties he owns in the Death Valley area and in Arizona.

There are 2,671 miles of multi-lane divided highway in operation or under construction in California.

FREEWAY EXHIBIT AT PASADENA DIAMOND JUBILEE



District VII, State Division of Highways, participated in Pasadena's Diamond Jubilee celebration by exhibiting a series of 33 enlarged photographs illustrating the planning and building of freeways. The display, set up in the Civic Center Plaza, was a feature of State and County Day, May 22, a part of the week-long observance of the 75th anniversary of Pasadena's incorporation, sponsored by the Pasadena Municipal Employees Association and the Pasadena Board of City Directors. Hundreds of interested visitors saw the photographs, which were 36 inches square, and many asked for freeway literature, which was supplied by Raymond F. Law, Assistant Information Officer.

Simatovich Retires; Johnson Named Richmond-San Rafael Bridge Head

Walter F. Johnson, senior bridge engineer, California Division of Highways, has been assigned as resident manager of the Richmond-San Rafael Bridge, succeeding A. P. Simatovich, who has been in charge of operation and maintenance of the toll facility since it was opened to traffic in September, 1956.

Simatovich has left State service after more than 15 years of work in bridge design, construction, and operation. He was associated with the Richmond-San Rafael project on design since its inception in 1950, and served as resident engineer during the construction phase beginning in 1953.

He is a native of San Francisco and was graduated from Stanford University in 1930. Before entering State service in 1946 he worked on bridges and forest highways with the U.S. Bureau of Public Roads and in other engineering activities for other Federal Government agencies.

Johnson, the new bridge manager, is a native of San Jose and a graduate of Oregon State College. He served with the Army Engineers in the Pacific Theater, then was office engineer for a dam construction project in Idaho.

Since joining the Division of Highways in December, 1947, as a junior civil engineer in the bridge department, he has held a variety of bridge construction and design assignments. For the past four years he has concentrated on special research studies.

California has 1,200 miles of freeways operating or under construction.

Hydraulic Model

Energy Dissipator Tested In Los Angeles Laboratory

By A. D. MAYFIELD, Supervising Highway Engineer; K. E. McKEAN, Senior Highway Engineer; and A. B. SHURTLEFF, Associate Highway Engineer



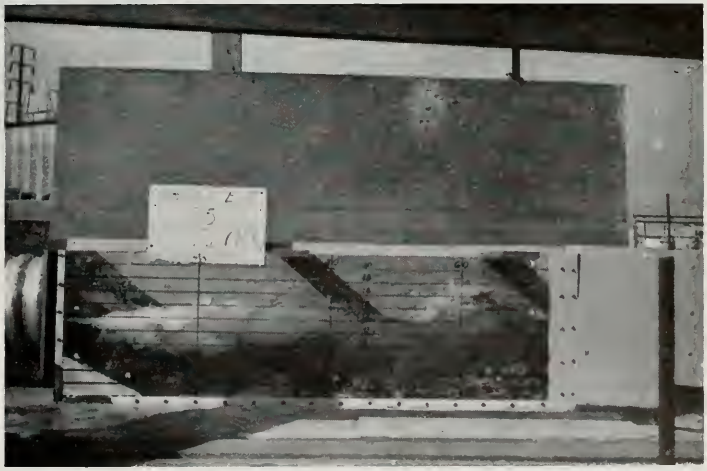
A highway culvert can be defined as a grade separation passing runoff water under highway traffic. From an operational and maintenance standpoint, the ideal culvert would be one that retained the naturally established conditions of flow unchanged. This means that the size and shape of the stream, and also alignment, grade and roughness of the natural channel would remain unchanged. From a cost standpoint, such design criteria are unrealistic. Instead, culvert pipes, boxes, or arches, which have a reasonable culvert barrel section, are generally used.

Minimum-sized culvert barrel sections produce high outlet velocities which may cause serious outlet erosion and downstream damage to abutting property. To eliminate the damage, the high outlet velocities coming from the culvert are reduced by the use of a Hydraulic Energy Dissipator.

Studies Are Made

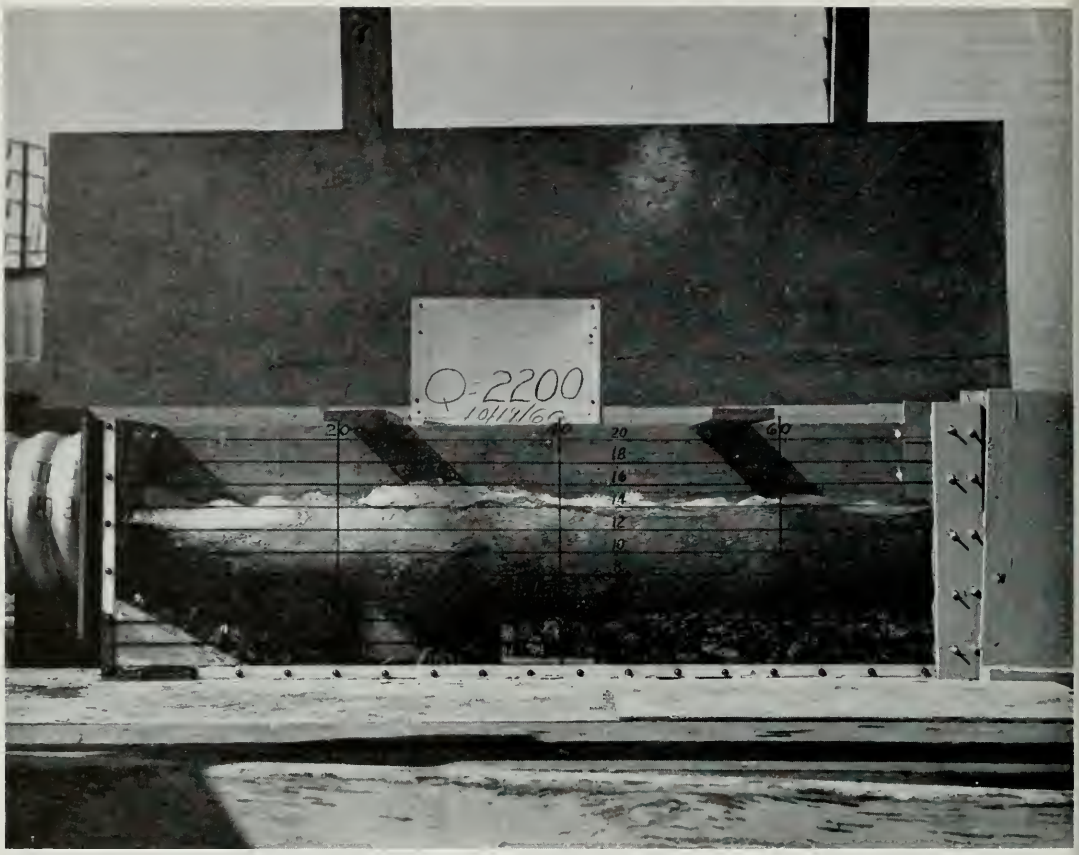
During the design of the Santa Paula Freeway (State Sign Route 126), it became apparent that the design of a Hydraulic Energy Dissipator should be considered for the culvert to be constructed under the freeway at Harmon Barranca, which is about three miles east of the City of Ventura. Studies indicated the fourteen-foot diameter field assembled plate structure would carry the flow that was expected to occur once in one hundred years, but velocities higher than the natural stream velocities could be expected to occur at the culvert outlet during times of high flow. The Barranca is an uncontrolled natural stream about fifty feet deep and has nearly vertical side slopes in the vicinity of the freeway crossing. Because the soil in the Barranca is an easily erodible, fine, sandy loam, it was decided that a Hydraulic Energy Dissipator should be designed to reduce the culvert outlet velocity to the velocity of flow expected in the natural stream.





The above photos show some of the different combinations of lengths and arrangements of appurtenances which were tested. Some 20 test runs were conducted with various quantities of flow and different dissipator lengths.

The Hydraulic Energy Dissipator design chosen was a Hydraulic-jump-type Stilling Basin, designed using the simple energy relationships. (See "Hydraulic Energy Dissipators" by Eleva Torski.) The structure proposed was



The model of the final Hydraulic Energy Dissipator chosen as a result of the tests. This final design, shorter and less complicated than the original prototype structure, will cost some $3,800 less.

a large, concrete stilling basin twenty feet wide, fifty-nine feet long, and fourteen feet deep. The cost of this structure was estimated at $12,600. After the theoretical design of the structure had been made, a model test of the structure was made to determine its hydraulic adequacy.

A wood and transparent plastic model of the dissipator was constructed from plans drawn by the District VII Drainage Section. (See accompanying sketch "Scale Model of Hydraulic Energy Dissipator"). The model of the Hydraulic Energy Dissipator was installed in the City of Los Angeles Hydraulics Laboratory at 3009 Northern Avenue, Los Angeles, by the laboratory personnel under the supervision of Howard D. Hopper. The actual testing was carried on under the supervision of A. B. Shurtleff and C. E. Dresser of the Division of Highways, District VII, Drainage Section.

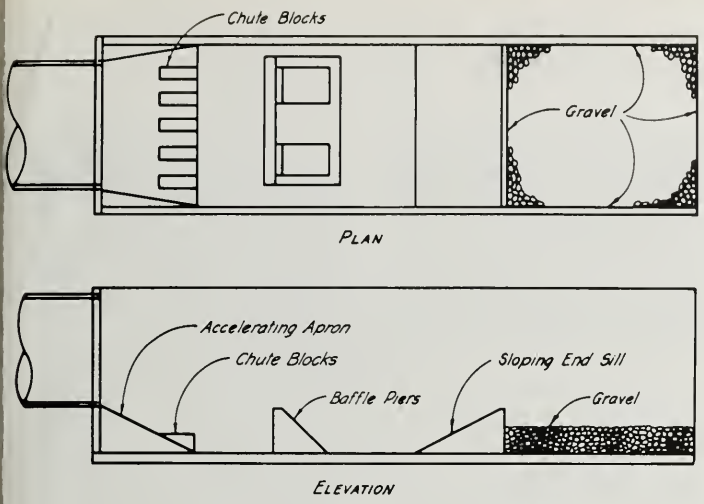
Testing Procedure

The testing procedure was designed to determine if the Hydraulic Energy Dissipator would:

(1) Reduce the outlet velocity of the culvert to that of the natural stream under various flow conditions;

(2) Minimize the tendency for the stream bed to erode downstream under various flow conditions.

The testing procedure was also planned to determine if it would be possible to reduce the cost of the Hydraulic Energy Dissipator by reducing the size and the amount of appurtenances. Accompanying photos show some of the different combinations of lengths and different arrangements of appurtenances which were tested. Some twenty different test runs were conducted with various quantities of flow and various combinations of dissipator appurtenances and different dissipator lengths. The model of the final Hydraulic Energy Dissipator design chosen to fulfill the two primary functions of the dissipator is shown in the accompanying photo. This final design was shorter and less complicated than the original design and is estimated to cost $8,800.



SCALE MODEL OF HYDRAULIC ENERGY DISSIPATOR FOR HARMON BARRANCA

A wood and transparent plastic model of the above dissipator was constructed from plans drawn by the District VII Drainage Section.

This means that there will be a savings in cost of $3,800 in the prototype structure as a result of the model testing.

Other Test Results

Some of the other test results for this form of dissipator structure that will be useful in the designing of Hydraulic Energy Dissipators for future culverts are as follows:

(1) The sloping end sill was inferior to the vertical end sill in preventing downstream erosion.

(2) The baffle piers were necessary to keep the erosion to a minimum at the outlet and of the Energy Dissipator.

(3) The theoretical calculations for the amount of energy dissipated by the dissipator were substantially correct.

(4) The chute blocks were not necessary.

(5) It was found the dissipator could be made much shorter than was calculated, using established criteria.

A full report on the Hydraulic Energy Dissipator model testing for Harmon Barranca is available for inspection at the Division of Highways, District VII, Drainage Section office.

Acknowledgment and thanks are extended to Mr. Swan and Mr. Doran of the City of Los Angeles, Bureau of Engineering, Storm Drain Division, for the use of the City's Hydraulic Laboratory for these model tests. Their cooperation and the cooperation of their staff was essential to the successful completion of these tests.

Car Registrations Up 3.3% for 1960

Motor-vehicle registrations in the United States totaled 73,895,274 during 1960, State agencies have reported to the U.S. Bureau of Public Roads. This is a gain of 2.4 million vehicles over the 1959 registrations. The 3.3 precent rate of increase is one-fourth less than the 4.3 percent increase of the preceding year.

The 1960 total included 61,682,036 passenger cars, 272,167 buses, and 11,941,071 trucks.

The State Department of Public Works has advertised $227,873,700 in highway projects since January 1.

San Mateo Streets

Continued from page 43 . . .

stressed box girder bridge, consisting of two parallel structures, composed of 15 and 17 spans.

The project included 1,615,000 cubic yards of roadway excavation. Much of the material was decomposed granite; however, several of the cuts contained very hard granite and other rock which required blasting.

The highest fill required by the contract, 37 feet, occurred on the two-mile-long embankment section through the city. Most of the excavation occurred between Parkridge Road and Buchanan Street, where cuts up to 100 feet in depth were made. In excavating these cuts, upwards of 400,000 cubic yards of hard rock and "tombstone" granite were blasted out.

It was necessary to import about 1,000,000 tons of material to complete embankment construction. The imported material was obtained from a source approximately one-half mile north of the freeway.

The specifications permitted the Contractor his choice of placing the concrete pavement in single-lane widths separated with a contact joint, or placing the concrete paving two lanes in width without a contact joint, but with a longitudinal sawed joint at the lane line. The Contractor elected to place the concrete pavement two lanes in width with one pass of the equipment train. The paving operation was started on the north roadbed at the west end of the project and progressed without interruption to the east end of the project, thence back on the south roadbed to beginning of project.

The paving train, barring the few breakdowns, traveled at the rate of about 500 feet per hour. Production was good, occasionally exceeding 2,000 cubic yards of concrete per day.

Transverse joints at 15-foot intervals, and the longitudinal joint at the lane line, were formed by sawing to a depth of two inches. The final profile index of the pavement, as determined by a California Profilograph, averaged 2.7 inches per mile.

General Superintendent was William Loy, Joseph MacDonald was Resident Engineer and Joseph Hoban was Bridge Department representative.

Bank Protection

Division Publishes New Reference Book

An illustrated reference book, *Bank and Shore Protection in California Highway Practice,* has recently been published by the State Division of Highways.

The book, a comprehensive examination of devices used to guard against erosion from streams, rivers and surf, is the product of research, field studies and committee work by the Division of Highways Joint Bank Protection Committee.

The committee was established by former State Highway Engineer G. T. McCoy February 15, 1959. It includes representatives of the Division's Bridge, Construction, Design and Maintenance Departments.

The long-term study covered "primarily the special treatment of banks of streams, lakes or tidewater and secondarily the treatment of highway embankment to prevent erosion by surface waters . . ."

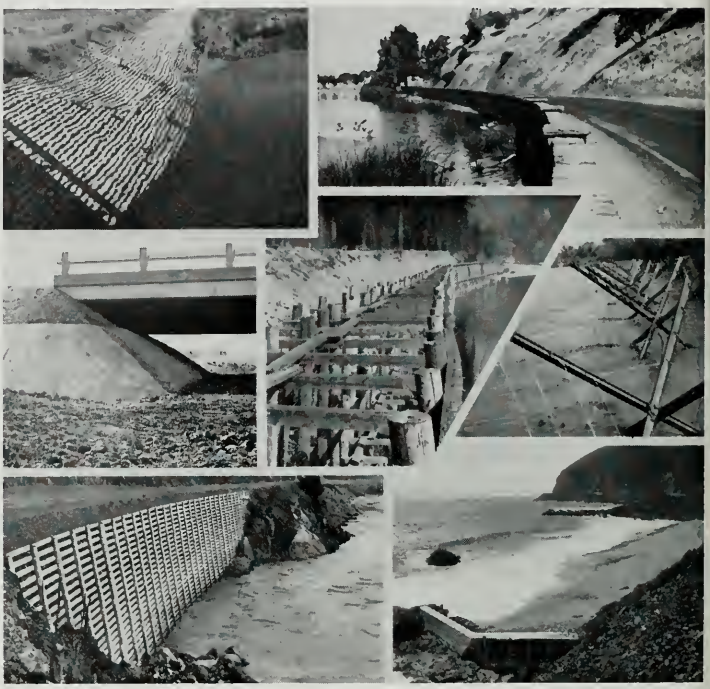
The 423-page report is divided into nine chapters. It contains nineteen tables, four design charts, 72 drawings and several hundred photographs including many old pictures of protection devices of former years.

There are also 21 general findings with respect to past practice and performance, and 14 general recommendations. Many of the recommendations have already been adopted by the Division of Highways as studies progressed.

Appended to the main report is an extensive bibliography listing 250 references; three early reports on bank and shore protection; and a list of abbreviations and definitions of special terms.

This first chapter outlines the background of the study and the procedures followed. It also contains a review of bank and shore protection devices used prior to 1949.

Hazards of erosion and hazards of location are covered in the second and third chapters. Various protective devices are classified in chapter four.



This photo montage of various protective devices against water erosion appears on the cover of the Division of Highway's new book on bank and shore protection.

Chapter five covers design principles for the four basic methods of dealing with the problem of waves or high-velocity stream flow attacking highway embankments—installing embankment armor, reducing the force of attacking water with such facilities as pile retards or permeable jetties, moving the attacking water away from the embankment, or moving the road away from the hazard.

Chapter six covers construction procedures. Planning is discussed in the seventh chapter, and chapter eight deals with maintenance of bank protection devices.

The final chapter stresses the importance of coordination between various departments in planning adequate bank and shore protection.

An interesting item in the appendix is a list of "landmark patents" for bank and shore protection devices dating back to 1870.

It is believed that the book will be helpful to engineers and other technicians who must be concerned with bank and shore protection in connection with various construction projects.

Copies may be ordered from the State Printing Division, Documents Section, Sacramento 14, California. Price is $3.12 in California (includes tax), $3.00 in other states and $3.50 outside the United States.

Agreement Readied On College Building

The Trustees of the California State Colleges and the State Department of Public Works have entered into an agreement that assigns to the State Division of Architecture a substantial workload of planning, design, and construction supervision for the colleges during the next two fiscal years, according to Director of Public Works Robert B. Bradford.

Under the master plan for higher education, enacted by the Legislature last year, the new Board of Trustees has full control of the building program for the colleges starting July 1, 1961. The trustees had already established a policy of using the services both of the architecture division and of private architects whom it will employ by contract. The agreement for architecture division services runs until June 30, 1963 and may be extended from year to year beyond that.

In general, it gives the state architects and engineers the go-ahead on all college work they started before July 1, 1961, and, with a few exceptions, all of the college building projects in the 1961-62 Budget Act.

In announcing the agreement to the employees of the architecture division, Bradford commented, "In my opinion, this agreement provides two years within which the department and the division can show the new state colleges organization that the Division of Architecture can do a thoroughly satisfactory job for them. During this time, the division is assured of doing most of the state college work.

"I am assured by the trustees that they look forward to a friendly, productive, and continuing client-architect relationship with the Division of Architecture. Let me urge each person in the division to devote his best efforts to achieving this result."

The agreement establishes for the division a total current workload of about $120,000,000 beginning July 1, which includes state college work valued at $35,300,000.

During fiscal year 1960-61, $107,000,000 worth of projects were put under construction by the architecture division. Of this total $9,000,000 was performed by private architects under contract to the Department of Public Works. The balance of $98,000,000 is a production record for the division and represents both the largest amount of work completed in a fiscal year and the greatest production rate per employee.

Department Lists Recent Retirements

Headquarters Office

Ernest M. MacDonald, Principal Right of Way Agent, 30 years.

District VI

Joseph M. Stewart, Highway Equipment Operator-Laborer, 28 years.

District VII

Nellie G. Carney, Senior Account Clerk, 12 years; William M. Deamer, Highway Leadingman, 25 years; Leland W. Fisher, Junior Engineering Aid, 30 years.

District XI

Taft Macias, Highway Foreman, 26 years.

State-Owned Toll Bridges

Elmer E. Lien, Toll Collector, 10 years.

Shop 4

Lowell M. Kresky, Automobile Mechanic, 34 years.

IN MEMORIAM

District VII

Elmer W. Burroughs, Associate Right of Way Agent

District XI

John C. Gage, Engineering Aid II

NEW U.S. 60 FREEWAY

The State Department of Public Works has warded a $4,857,000 contract for construction of 5½ miles of freeway on U.S. 60 between Sunnyslope and Orange Street in the City of Riverside.

Department Members Win 25-Year Awards

DIVISION OF HIGHWAYS

District III
Gerry H. Brumund
Otto E. Claussen

District IV
Henry C. Suenderman
Manda Tessmann

District V
Fred C. Moore

District VI
Maurice E. True

District VII
Willard Brown
Marie Burrell
Charles Chacanaca
John S. Mackie

District X
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Raymond J. Geimer
Herman R. Jantzen
Edward L. Tinney

District XI
Roy Still

Bridge Department
Lloyd B. Dale
Jerrold M. Gayner
Jack Sylvester

Shop 8
Lawrence D. Sandoval

Headquarters Office
Laura D. Cameron

DIVISION OF ARCHITECTURE

Los Angeles
Bernard S. Harder

San Francisco
Douglas J. Murray

Sacramento
Henry R. Crowle
Robert C. Younger
James J. Grant

The State Department of Public Works has awarded a $403,000 contract for a new Colusa Basin Bridge on Sign Route 20 west of Colusa.

STATE OF CALIFORNIA

EDMUND G. BROWN, *Governor*

DEPARTMENT OF PUBLIC WORKS

PUBLIC WORKS BUILDING — 1120 N STREET, SACRAMENTO

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FRANK A. CHAMBERS Chief Deputy Director

RUSSELL J. COONEY . . Deputy Director (Management)
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JOHN H. STANFORD Assistant Director

JUSTIN DuCRAY . Departmental Management Analyst
S. ALAN WHITE . . Departmental Personnel Officer

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E. R. HIGGINS Comptroller
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L. L. FUNK Planning Engineer
MILTON HARRIS Construction Engineer
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H. B. LA FORGE . Engineer of Federal Secondary Roads
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G. M. WEBB Traffic Engineer
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A. L. ELLIOTT Bridge Engineer—Planning
L. C. HOLLISTER . Bridge Engineer—Special Projects
I. O. JAHLSTROM . . . Bridge Engineer—Operations
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District VII

E. T. TELFORD . . Assistant State Highway Engineer

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J. DEKEMA District XI, San Diego
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THOMAS CHINN . Supervisor of Scheduling and Control
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W. F. PARKS Supervisor of Office Services
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Area Construction Supervisors

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CLARENCE T. TROOP Area III, Los Angeles

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1911

Sacramento, Aug. 9, 1911—"The newly constituted California Highway Commission, consisting of the three appointed members of the Advisory Board of the State Engineering Department of California, Mr. Charles D. Blaney of Saratoga, Mr. N. D. Darlington of Los Angeles, and Mr. B. A. Towne of Ladi, this day convened at the State Capitol at Sacramento and proceeded to effect permanent organization in accordance with the terms of that certain resolution on file with the Secretary of the Advisory Board of the Engineering Department, as follows: . . ."

The minutes of the first meeting of the California Highway Commission continue with the spelling out of the Commission's jurisdiction and powers as contained in the Advisory Board resolution. The principal tasks are defined as (1) responsibility for constructing and acquiring a system of state highways at a cost not to exceed $18,000,000 (as provided in the 1909 bond act) and (2) "to perfect such organization as they may deem necessary to carry on with celerity and efficiency" the work of creating this State Highway System.

The minutes further note that Room 118 in the State Capitol Building was assigned to the Commission as a temporary office; that Mr. Towne was elected Chairman of the Commission; and that W. R. Ellis was chosen as secretary. The minutes conclude:

"Following a conference with His Excellency Hiram W. Johnson, Governor, the Commission adjourned subject to the call of the Chairman."





1961

Conferences of the California Highway Commission with the Governor still take place from time to time. Here is a recent photograph taken in Governor Edmund G. Brown's study.

Seated, left to right, are Commissioner John J. Purchio, Chairman Robert B. Bradford, and Governor Brown.

Standing, left to right, Commissioners John Erreca, Arthur T. Luddy, Roger S. Woolley, Robert E. McClure, and Vice Chairman James A. Guthrie.

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Toll Bridge Project Is Expanded

The California Toll Bridge Authority took action on September 14 to provide for a high-level double-decked fixed span structure for the San Mateo-Hayward Bridge where it crosses navigational waters, instead of retaining the existing lift span in connection with the bridge remodeling project.

Estimated over-all cost of the high-level plan is $65,000,000, as compared with $35,000,000 for the original proposal to convert the existing two-lane facility to a four-lane low-level concrete trestle and a double-deck lift span.

The Toll Bridge Authority, with Governor Edmund G. Brown presiding, acted favorably on a recommendation by Director of Public Works Robert B. Bradford.

Funds for increasing the capacity of the bridge were made available by the 1959 Legislature out of toll revenues of the San Francisco-Oakland Bay Bridge and the San Mateo-Hayward and Dumbarton Bridges. However, that legislation imposed a time limit of December 31, 1962, on the availability of these revenues. At the 1961 session, the Legislature extended the toll revenue commitment until June 30, 1964, which will provide sufficient funds for the high-level structure.

The lift span on the present bridge must be raised from six to 12 times a day for the passage of marine traffic, sometimes resulting in long vehicular tieups. An increase in ship traffic as well as vehicular travel in the area is expected.

The high-level fixed span structure will have a daily traffic capacity of 50,000 vehicles, according to Norman C. Raab, Chief of the Division of San Francisco Bay Toll Crossings. This would provide adequate, free-flowing traffic service for many years.



Governor Edmund G. Brown, left, chairman of the California Toll Bridge Authority, is shown discussing with Lieutenant Governor Glenn M. Anderson, an artist's sketch of the transition structure and double-deck portion of the proposed high-level fixed span San Mateo-Hayward Bridge improvement. The Authority approved a recommendation to substitute the high-level structure for the originally planned double-deck lift span over the navigational channel, as made possible by recent legislation. Other members of the Authority are Director of Finance Hale Champion, Director of Public Works Robert B. Bradford and James F. Thacher of San Francisco, public member.

The next step in preparing for the high-level structure will be to obtain the necessary permits from Federal Government authorities.

Work on the four-lane concrete trestle section of the bridge is now under way. The trestle section has been designed for possible ultimate widening to six lanes. The fixed-span high level section would be built for six lanes initially, according to Raab.

The San Mateo-Hayward Bridge was completed in March, 1929, as a privately-owned toll bridge. The State acquired it in 1951.

California Highways and Public Works

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Bradford Heads New Transport Agency



Robert B. Bradford

The formation of an eight-member Cabinet to serve as the policy-making body for the executive branch of State government was announced on October 1 by Governor Edmund G. Brown. The Cabinet includes four newly-appointed administrators of new agencies established by the 1961 Legislature.

One of the statutory posts is Administrator of the Highway Transportation Agency. The Governor's appointee to this position is Robert B. Bradford, State Director of Public Works since January, 1959.

By law, the Highway Transportation Agency will include the Departments of Public Works, Motor Vehicles and California Highway Patrol. Governor Brown also assigned to the Administrator of this agency a reporting responsibility with regard to the San Francisco Bay Area and Los Angeles Metropolitan Transit Authorities, the San Francisco Port Authority and the Board of Harbor Commissioners for Humboldt Bay.

Under separate legislation, the Department of Public Works now also includes a Division of Aeronautics, formerly the California Aeronautics Commission.

The Governor announced that he would appoint a successor to Bradford as Director of Public Works within a short time.

The other three new statutory agencies are the Youth and Adult Corrections Agency, the Natural Resources Agency, and the Health and Welfare Agency.

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SACRAMENTO, CALIFORNIA

Baker Grade

25 Miles of U.S. 91-466 Become Full Freeway

By L. M. BARNETT, District Construction Engineer



A $5,000,000, 25-mile section of Interstate 15, carrying U.S. 91 and U.S. 466 on the stretch between Barstow and Las Vegas is now completed. Work was started by Contractors Gordon H. Ball, Ball & Simpson, and E. L. Yeager in April, 1960, and the first 14 miles were opened to traffic on July 19, 1961. The entire project was completed in September.

Beginning 1½ miles east of Baker (the junction with Route 127 to Death Valley), the portion already completed has long been referred to as the "Bloody Baker Grade." This name resulted from a number of spectacular traffic accidents, mainly of the head-on collision type, which have taken place due to excessive speed on the long westbound downgrade, sometimes at speeds over 100 MPH. While a new highway cannot be expected to put the damper on such drivers, it is expected that the new four-lane divided construction, with a 100-foot median area, will provide more protection for other motorists who sometimes become innocent victims of an "out of control" vehicle.

A dramatic shot of the Cima Road Overcrossing on the newly constructed Baker Grade project.

Accident Rate Normal

In recent years, due to aerial patrols and other special enforcement by the California Highway Patrol, the overall accident and fatality rate on the Baker Grade has not been greater than normal for a rural State highway carrying in the neighborhood of 5,000 vehicles per day. Weekend peak traffic volumes, which are swelled by the Los Angeles to Las Vegas recreational trips, frequently reach over 500 vehicles per hour in one direction. For these reasons, this project near the middle of the Interstate route between Barstow and the Nevada State Line (a distance of 111 miles) was selected for first construction.

One special feature of this project was the care taken to avoid disturbance of the native desert vegetation, in order to provide erosion protection and to act as a screen between the two opposing streams of traffic. Hauling on or crossing of the median was restricted during construction, except at designated places where it was necessary to obtain access for construction of bridges or drainage structures.

Beginning in the early design stages, the makeup of the structural section of the road, including pavement and base materials, has been of considerable

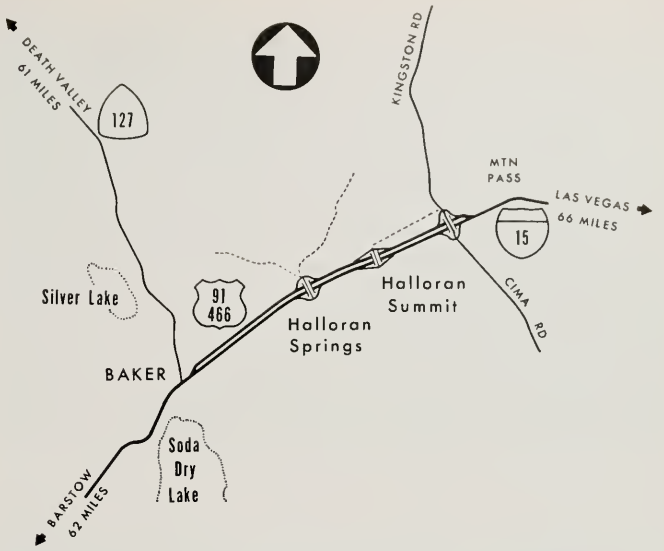


nterest. The sections finally adopted re shown in the accompanying ketches. One section is being used for he new roadbed and the other as an verlay of the existing roadbed. The ew roadbed utilizes a 7-inch asphalt oncrete pavement (an experimental ection) on an 8-inch aggregate base. Additional subbase (up to 6 inches) was called for over portions where poor basement soil was encountered.

Existing Road Resurfaced

The existing road was resurfaced to serve as the eastbound freeway roadbed through most of the project. The new pavement consists of three courses of asphalt concrete topped by ½ inch of open-graded asphalt concrete. Efforts by the Contractor and inspectors resulted in an unusually smooth riding surface on the resurfaced roadbed. Leveling courses were placed by means of motor graders with highly skilled operators. The old pavement had irregular profile and variable transverse slope. Both of these deficiencies were corrected by use of a planned grade line and single cross slope put into the first leveling course. The profilograph reading on the first 14 miles of resurfaced roadbed averaged 0.14 inch per mile.

Contrary to what might have been expected, high quality alluvial gravel was not easily found in the vicinity of this project. Assorted soft, mineral bearing rocks, frequently coated with an undesirable carbonate, were more typical. The carbonate apparently results from drying out of hot weather rainfall after seeping below the surface. It is found in thin layers and pocketed throughout depths of more than 20 feet in the alluvial deposits. It was rejected for use in the upper layers of the roadbed. Extensive preliminary studies for possible aggregate sources included 11 test pits, which were left open for viewing by prospective bidders on the construction work. Borrow material was obtained from 7 sites near to the road, selected for suitability of material and economy of haul. Hauling was by means of tractor scraper units; average haul being about three miles, with some hauls of base material over six miles.



The double-lined section of U.S. 91-466 in the obave map shows the location af the new section of Interstate freeway.

BELOW: Looking down the Boker Grade from Holloran Summit Overcrossing. Note the restarotion planting of Joshua and notive plants ot the Interchange.





A sign tells matarists of this safety rest area on U.S. 91-466 some 10 miles east of Baker.



An aerial of the same safety rest area shown in the above photo.

Water Is Scarce

Water, a scarce item on the desert, required for compaction of earthwork and base material, was supplied from two reservoirs, one at Halloran Summit and one at the northeast end of the project. Wells near Cima Road supplied the reservoirs. From the reservoirs, water was piped by gravity and booster pumps to six 10,000-gallon tanks, which were strung along the job at about one-mile intervals. Tanks were moved ahead as the work progressed toward the south. About 20 miles of six-inch steel water main were used, with deliveries of over 300,000 gallons per day at times.

Grading work consisted of shallow cuts and fills for the most part, but the Halloran Summit is crossed by a cut about one mile long and of 40-foot maximum depth.

Ten bridges were included in the project, with spans of 100 to 200 feet. All were of precast deck and substructure units, hauled to the project from a casting yard at Barstow. There were also three welded steel plate girder structures, providing crossings over the freeway at Halloran Springs, Halloran Summit, and Cima Road. Although the project reaches elevations over 4100 feet at the summit, a relatively mild winter and careful scheduling by the Contractor permitted almost continuous work. Summer thunderstorms and attendant localized flash floods posed some problems during the course of the job.

First Rest Areas

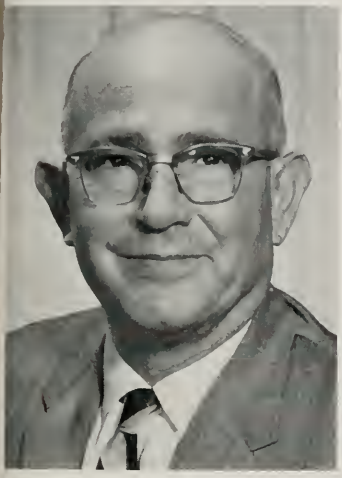
This project contains the first "safety rest areas" built as part of the road contract on an interstate job in District VIII as may be seen by photographs accompanying this article. The "safety rest areas" are within the right of way and have freeway-type exits and entrances. Parking areas, water supply and landscaping were provided under the contract.

The remote location of this project made it necessary to establish living quarters for both Contractor and State personnel. Facilities in Baker were soon overtaxed by the influx of construction workers, many of whom brought house trailers and families with them. At the time of peak con-

. . . Continued on page 5

Kofman Succeeds Judge Purchio on Highway Commission

Governor Edmund G. Brown has appointed Abraham Kofman, publisher of the San Leandro *Morning News* and the Alameda *Times-Star*, as a member of the California Highway Commission to replace John J.



Abraham Kofman

Purchio of Hayward, whom the Governor appointed to an Alameda County Superior Court Judgeship on September 7.

Kofman is a native of Brockton, Massachusetts, and has been in the newspaper business since his youth. He began with a newspaper distributorship in his home city, and continued in this field when he moved to Norwich, Connecticut. He was active in civic affairs in Norwich, including service on the zoning board which administered the municipal roads.

He purchased the Alameda *Times-Star* in 1939 and started the San Leandro *Morning News* in 1950. His home is presently in San Jose, but he plans to move soon to Alameda County.

Kofman is a member and former director of the California Newspaper Publishers Association, and a member of numerous civic and fraternal organizations, some of which he has headed in the course of the years.

BAKER GRADE

Continued from page 4...



Like the proverbial parallel lines that are never supposed to meet, this section of the new U.S. 91-466 freeway extends for miles across the sun and cloud-potched desert.

struction work, eighteen State inspectors were living in quarters provided through temporary use of service station and motel buildings at Yucca Grove, near Halloran Summit. These buildings were within the freeway right of way and were removed during later stages of the work.

Resident Engineers on the job were C. M. Mauck and J. O. Erwin.

Judge Purchio, former Hayward city councilman and mayor, had served on the Highway Commission since January 15, 1960. He is a native of New York, a graduate of Fordham College and Fordham Law School, and served as an intelligence officer with the U. S. Air Force in Europe in World War II. He has practiced law in Hayward since 1947.

Study of New Bay Crossing Assigned

The Division of San Francisco Bay Toll Crossing has been assigned the completion of a study of a proposed toll crossing from San Francisco to Marin County by way of Angel Island. The Division had made the earlier study.

Completion of the study is directed by Senate Bill 1273 (Chapter 2142) of the 1961 Legislature, which appropriated up to $500,000 from the Highway Fund for the purpose, to be repaid out of the proceeds of the first sale of revenue bonds for construction of the crossing. The study will include comparison of an alternate route via Alcatraz Island.

Progress on U.S. 40 —

By J. G. MEYER, District Engineer



Scrapers move 1,500,000 cubic yards of material for embankment to widen U.S. 40 at American Canyon, and make this section eight lanes.

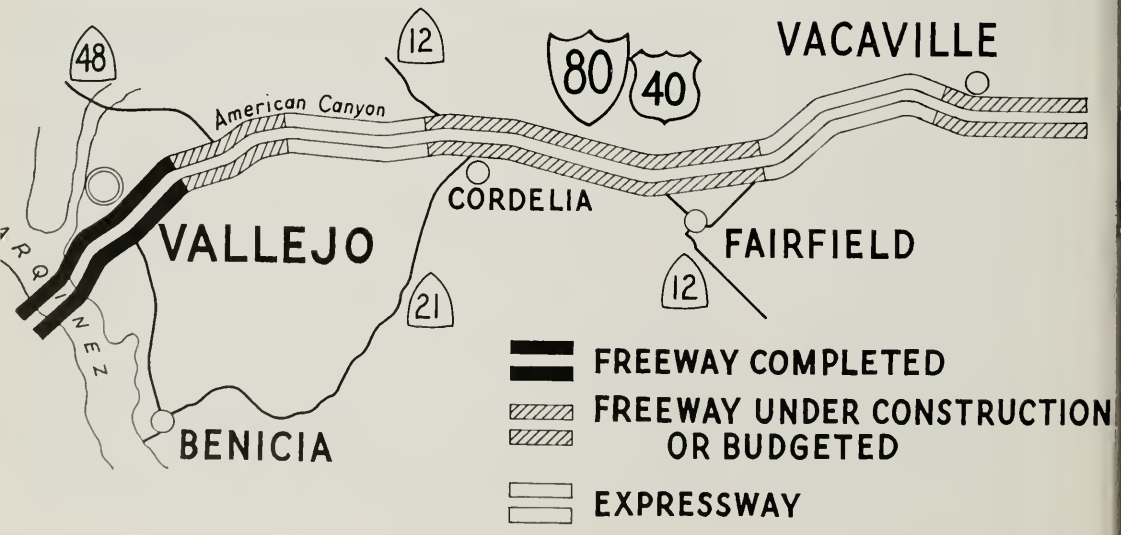


THE first half of the program of converting U.S. 40 in District X to full Interstate freeway standards is drawing to a close and we find that the schedule originally proposed has been met both in time and accomplishments.

In 1956 the last two contracts were awarded that completed the reconstruction of U.S. 40 to four-lane expressway standards just in time to start the new freeway program. Approximately $7,200,000 of construction monies had been expended between 1941 and 1956 to provide this facility.

When in 1956 the Federal Interstate Highway program was inaugurated, U.S. 40 was included in the Interstate

. . . Continued on page 9



—Carquinez to Sacramento

By ALAN S. HART, District Engineer



ORIGINALLY, of course, there wasn't any road between Vallejo and Sacramento. Barely a path, in fact.

Then John Marshall's discovery of gold sparked the beginning of California's economic development that was to include the evolution from paths to trails to wagon roads to highways to freeways.

But it wasn't until 1916, with the completion of the Yolo Causeway, that a vehicle—motor or otherwise—could be driven over the route year around. Before then, the usual annual flooding of the Yolo Bypass Basin dictated that the traveler to Sacramento detour south by way of Tracy, then up through Stockton. The three-mile ground-level route across the Basin would be hopelessly awash in several feet of water.

Incidentally, the Yolo Bypass Basin is a portion of the fertile north-south lowland strip that absorbs the flood waters of the Sacramento River. It runs the length of eastern Yolo County connecting on the north with the Sutter Bypass and on the south continuing into Solano County and down to the rich delta area. It is extensively cultivated.

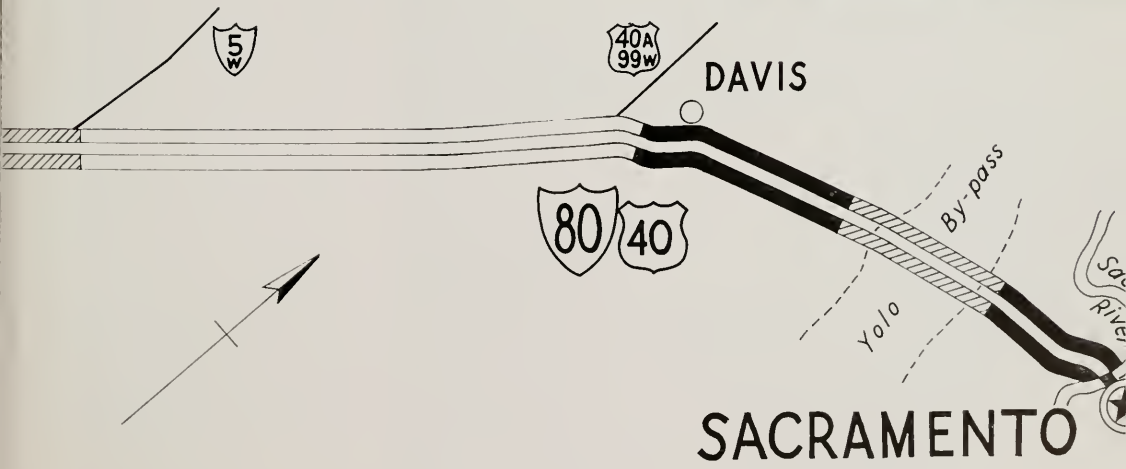
Best known as U.S. 40, the portion of this road in District III is also a section of U.S. 99W. And the entire route between San Francisco and the Nevada state line is a part of Interstate 80.

District X Formed

Solano County was a part of District III until 1924 when it was included in the newly formed District X. The boundary between districts is the Solano-Yolo county line which coincides with Putah Creek near Davis, and it is the 13 miles in Yolo County — Davis to Sacramento — that will be discussed in this article.



Aeriol view of U.S. 40 construction across Yolo Bypass, looking east, with structure portion of new six-lane freeway seen underway at right. Existing four-lane undivided causeway is dark line running diagonally from left center to upper right.



Today the status of this road as it now skirts to the south of Davis is 1) a new six-lane freeway from the county line to Swingle, 2) a new Yolo Causeway under construction, and 3) a four-lane freeway from the Causeway to the Sacramento River.

Briefly looking into the past: The first paving of the route in Yolo County was completed in 1915-16. It was an asphaltic surfacing over a cement concrete base, and extended from the Woodland Wye due west of Davis into and through that town over what is now a county road, Russell Boulevard. Adequate for the times, pavement width varied from 15 to 18 feet.

The section from Davis east to near the Causeway was completed about the same time under several contracts.

The Causeway, of course, was the most dramatic of those early day contracts. In fact, it was one of the first really big jobs of the then fledgling highway department. This two-lane structure, with a clear roadway width of 21 feet, was built of reinforced concrete piles and deck, with an asphaltic wearing surface called a Topeka Top.

Paving Completed

Also at this time, the paving between the Causeway and the Sacramento River was completed, making a total of 14 miles of surfaced highway across Yolo County.

Approximately one mile was dropped from the route in 1941 when a realignment bypassed Davis to the south. This was the first section of four-lane divided highway on District III's share of the route, and extended east to Swingle.

Last fall a new six-lane freeway, with provision for eight lanes, was completed on approximately this same alignment at a cost of $2.5 million.

In 1933 the Causeway was doubled in width when an all-timber trestle was constructed next to the south edge of the original structure. In 1950 a continuous lighting system was installed.

The new six-lane divided Causeway-freeway project which started in January of this year, will span the Yolo Basin with two structures connected by nearly a mile of embankment. Under a $6,950,000 contract with Fredrickson & Watson and Lew Jones Construction Co. of Oakland, the total 5.7-mile project will be on a new alignment beginning at the six-lane section at Swingle. It will be just south of the existing road.

The west Causeway will measure about 2,800 feet, the intervening fill section about 4,700 feet, and the east structure 8,500 feet. Both structures will be built as parallel bridges of three lanes each plus eight-foot shoulders, supported by cast-in-a-drilled-hole reinforced concrete piles. At some locations piles will be driven.

Possible 1962 Completion

In late August the project was about 30 percent complete with completion estimated for possibly late 1962 or sometime in 1963, depending on weather, availability of materials, and other unpredictables.

On the four miles between the Causeway and the Sacramento River, the major improvement following the 1916 job was completion of the Tower lift bridge in 1936. Then during 1951-54 a number of contracts totaling nearly $3,000,000 were let for construction of the present four-lane divided freeway on a new alignment to the south of the old road.

Future planning for this section calls for expansion to six lanes with the final mile just west of the river to follow a new, recently adopted alignment which will connect with a future freeway through Sacramento.

Ultimate plans include widening the entire 13 miles to an eight-lane full freeway.

Looking east along completed section of six-lane freeway in Yolo County. Interchange connects with city of Davis.



51 PROJECTS ADVERTISED

During August the Department of Public Works advertised for bids on 51 highways projects with an estimated value of $31,849,000. Since January 1, 1961, projects for $277,861,300 have been advertised. There were 59 contracts for $29,719,600 awarded dur- August and 49 contracts for $14,999,-500 were completed.

During August bids were opened for 60 projects for which 293 contractors' bids were received, an average of 4.9 bidders per project.



Looking south along current freeway construction on U.S. 40, city of Vallejo and San Francisco Bay in distance. Interchange will connect with relocated American Canyon Road.



Wagon drill in operation as first step in blasting for roadway excavation o fill at American Canyon. Blasted material will be used for fill below.

PROGRESS ON U.S. 40

Continued from page 6 . . .

System as Interstate 80 and a new era in construction began. As the first step in converting this pioneer route to full freeway standards, bonds were issued for the construction of a parallel bridge across the Carquinez Straits, new toll facilities and the reconstruction of the existing bridge and approaches. At the same time Federal Interstate funds and State highway user monies were allocated to convert U.S. 40 from the bridgeheads through Vallejo to the foot of the American Canyon to full Interstate freeway standards, all construction being done to provide room for a minimum of six traffic lanes.

New Parallel Bridge

The first four contracts were awarded in a total amount of approximately $17,540,000. These bond monies provided a new parallel bridge, revamped the old bridge and approaches, and installed the new toll plaza ready for traffic.

Another contract was awarded to Fredrickson & Watson Construction Company and Ransome Company on May 14, 1956. On December 6, 1957, the Director of Public Works accepted the project which provided an eight-lane divided facility, 1.25 miles long, from the bridgeheads to just north of the Vallejo "Wye" at a cost of $1,885,000.

The first road contract utilizing highway user funds to convert the expressway through part of Vallejo to a freeway was awarded April 23, 1957, to Harms Bros., C. M. Syar, and Erickson, Phillips & Weisberg. On January 6, 1959, 1½ years and $4,513,000 later, the new six-lane facility with six overcrossings and a separation structure at the intersection of U.S. 40 and State Route 74 (Benicia Road). This project was only 3.5 miles long, but it represents the most highly developed section of the entire 43.3 miles of U.S. 40 in District X.

On April 4, 1960, a contract was awarded to Gordon H. Ball to construct 4.4 miles of six lanes divided freeway with six bridges, three overcrossings, a separation structure at the intersection of U.S. 40 and Sign Route 21 and an overhead structure at Cordelia. Construction is 90% complete and will be finished in January 1962 at a cost of $4,178,000.

Widening Is Planned

Plans are now being prepared to widen SSR 21 between Cordelia and Benicia to freeway status. This is due to the attractiveness of the route for East Bay residents bound for Sacramento and points east. Upon completion of the Benicia-Martinez Bridge, this route is destined to increase in popularity and is part of the reason for building into the U.S. 40 project room for two additional lanes so that minimum disturbance of public traffic will result due to future widening.

On June 27, 1960, a contract to eliminate the "Fairfield Lights" was awarded to Charles L. Harney, Inc. This project is 1.6 miles long and provides a six-lane divided freeway, two bridges, one overhead, and a separation structure at U.S. 40 and Sign Route 12. The anticipated cost of

eliminating the last intersection controlled by traffic signals between Sacramento and San Francisco is $1,960,000. This project should be ready for traffic late in November 1961.

On February 16, 1961, a contract was awarded to Wunderlich Company for constructing 4 miles of eight-lane divided freeway, one overcrossing and a separation structure at the intersection of U.S. 40 and Sign Route 48 at a cost of $4,800,000. This is the first project for widening the American Canyon section of U.S. 40. Foundation problems have been intensified by the heavy grading features of the project which include fill heights of 100 feet and cuts having depths of 260 feet.

Subdrainage Increased

Stabilization trenches were provided for in the contract, but after opening up new cuts and benching into the old fills and encountering vast quantities of water in both locations, it was necessary to increase all subdrainage items. To date this amounts to an increase of 10% to 15% of the original drainage items.



Looking north on U.S. 40 in Solano County, Abernathy Road interchange in foreground, city of Fairfield in background. Interchange under construction near Fairfield will eliminate last remaining traffic signal between Sacramento and San Francisco.



Looking north on U.S. 40 near Cordelia. Green Valley Road overcrossing in foreground, interchange with State Sign Route 21 (to Benicia) center; Mangels Road interchange in background.

Conversion of a five-mile section of expressway through the Vacaville-Nut Tree area is financed in the 1961-62 State Highway Budget with an allocation of $5,400,000. Bids for this project will be opened November 15, 1961.

The remaining sections of U.S. 40 in Solano County are either in the stage of completion design, with right of way acquisition in progress; or in various stages of design work.

Thus today we stand with 24% of the 43.3 miles constructed, 39% planned and ready to advertise, and 37% under design. If financing can be arranged, 63% of U.S. 40 in District X could be completed by 1965.

The target date of 1972 for completion of the Interstate System may be difficult to hit for the system as a whole, but it would appear that District X will be able to anticipate that date by several years, given adequate financing.

Elysian Viaduct

Key Structure in Complex L.A. Interchange Nears Completion

By ALBERT P. BEZZONE, JR. and GORDON MORSE, Associate Bridge Engineers



THE COMPLEX Golden State-Pasadena Freeway Interchange now nearing completion, features unusual structural solutions to several unique problems created by the difficult site and alignment controls. Because of the restrictions imposed by the Los Angeles River, the Arroyo Seco Channel, the existing Pasadena Freeway, extensive Southern Pacific Railroad yards and existing city streets,—all tightly concentrated—the layout of interchanging ramps had to be custom tailored to fit.

Key structure is the half mile long Elysian Viaduct which will carry Golden State Freeway traffic over the many obstructions below, and at its southerly end develops into a system of curved ramps which cross and merge in an intricate pattern to make possible the interchange with the Pasadena Freeway. The viaduct is a minimum of eight lanes in width and features long span welded steel girders in the northerly section and concrete box girders in the southerly section where the structure develops into three levels.

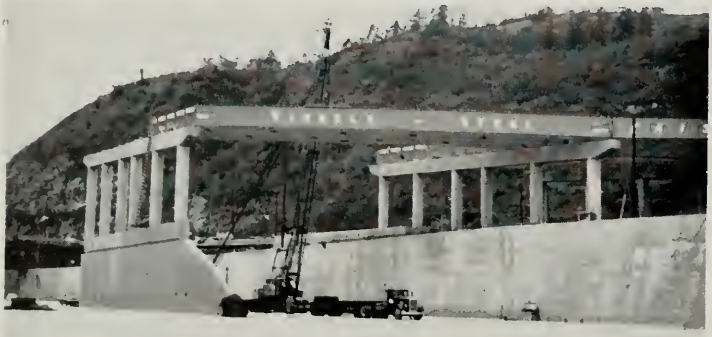
During construction emphasis was placed on minimizing inconvenience to traffic by scheduling construction operations and timing lane closures for



The numbers in the above photo indicate various construction features of the interchange.



The overhanging abutment at the north end of the Arroyo Seco Channel Off-Ramp will support the box girder shown dashed in the photograph.



Erection of structural steel for the Elysian Viaduct is shown at the crossing of the Los Angeles River.



Steel erection for the Elysian Viaduct is shown at the crossing of the Southern Pacific Railroad yard.

off peak hours. Movement of the steel girders to the site and erection of steel over the Pasadena Freeway were often scheduled for early morning hours. Daytime erection of girders over the Southern Pacific tracks was made possible by the cooperation of the Southern Pacific in scheduling and routing trains.

Curved Steel Bridge

The first curved steel girder bridge in California carries the westbound on-ramp connection from the Pasadena Freeway across the Arroyo Seco Channel at a sharp skew and on a 400 foot radius curve. With all girders curved to fit the roadway curvature, this structure may be the first of its kind anywhere.

The girders were fabricated by cutting the flange plates to the prescribed curve and welding web plates to the curved flanges in the conventional manner. The girders were assembled in the shop in braced pairs and trucked to the job site in an after-midnight caravan timed to avoid heavy traffic.

The curved girders produce a symmetrical deck section with uniform girder spacing and slab overhangs which result in economy in formwork. Additional advantages are the simplicity of detail and the functional, attractive appearance.

Prestressed Carrying Girders

Three ramps cross Arroyo Seco Channel on severe skews. Prohibitively long spans would have been required to bridge the entire channel and yet not supports were allowed in the channel. This problem was solved by providing prestressed carrying girders to pick up the heavy column loads. The carrying girders were concrete box structures reinforced with post-tensioned high strength steel rods. Working forces for these girders varied from six million to nine million pounds.

The carrying girder at the Arroyo Seco Channel On-Ramp was nine feet deep by twenty feet wide and consisted of two cells. The carrying girders at the Arroyo Seco Channel Off-Ramp and at Bent 22–9 of the Elysian Viaduct were single cell box structures ten feet deep by fifteen feet wide.

Variety of Structural Types Used

The Los Angeles River-Riverside Drive Modification provides four new lanes northbound from the existing Dayton Avenue Bridge. This is accomplished with a complicated transition structure at Dayton Avenue and an elevated structure along the existing channel wall. Total length of new construction is 578 feet and is supported on piles for its full length to avoid adding pressure to the Los Angeles River Channel lining.

Railroad Underpasses south of the main viaduct carry the Union Pacific and The Atchison, Topeka and Santa Fe tracks over the Golden State Freeway. The Humboldt Street Underpass carries both vehicular and rail traffic. The railroad section is a riveted plate girder and the highway section is a concrete box girder which provides space for a large number of utilities in its cells. The Lacy Street Underpass carries two tracks of The Atchison, Topeka and Santa Fe and features spans almost 100 feet in length.

The Cypress Avenue Pedestrian Overcrossing bridges all of the lanes of the Pasadena Freeway with a span of 147 feet. This span is the longest for a steel pedestrian structure in California. In addition to pedestrian traffic, the structure accommodates a 30 inch pressure gas line.

Structural features include all welded construction, light steel decking in the long center span and a conventional concrete deck slab in the



This photograph shows the curved steel girders supported by the prestressed carrying girder over the Arroya Seca Channel.



This photograph shows six utilities emerging from the abutment of the Humboldt Street Underposs.



The Cypress Avenue Pedestrian Overcrassing is a welded steel structure, 440 feet long, which replaces an old timber truss structure.



The On-Ramp to the Elysian Viaduct from the south is a steel girder structure curved to fit the roadway curvature.

comparatively short side spans. Two existing concrete piers constructed many years ago for a proposed vehicular crossing at Cypress Avenue were modified for use as supports for the pedestrian structure.

Arroyo Seco Channel Ramps

The ramp structures which cross the Arroyo Seco Channel and provide on and off connections to the Pasadena Freeway were a formidable challenge to the bridge designers. Because of the curvature and sharp skew angle of the channel crossings, prestressed carrying girders were used to maintain an unobstructed channel.

In addition, at the north end of the Off Ramp Overcrossing an overhanging rigid frame abutment was used to shorten the span over the Pasadena Freeway inbound lanes. This is illustrated in an accompanying photograph.

The On-Ramp Overcrossing combines the use of long continuous concrete box girder spans with the support provided by the special prestressed carrying girder, to produce a unique structure. The northerly abutment has an eccentric footing which is set back to clear the existing channel wall footing.

Design and Construction Staff

Design engineers for the various structures were as follows:

Elysian Viaduct: A. P. Bezzone, Jr., Ostap Bender.

Humboldt St. Underpass: H. J. Berbert.

Humbolt St. Pumping Plant: R. F. Lee, J. A. Tryens.

Lacy Street Underpass: Ostap Bender.

Riverside Drive Modification: A. E. Dirckx.

Cypress Ave. Pedestrian Overcrossing: Ostap Bender.

Avenue 26 Undercrossing: R. F. Lee.

Arroyo Seco Channel On Ramp: L. H. Caldwell.

Arroyo Seco Channel Off Ramp: R. E. Shields.

The Resident Engineer for the project is Kenneth P. Mock. Bridge Resident Engineer is Gordon Morse, with A. E. Waddel, A. Sousa and T. Fraser as his principal assistants.

General Contractor for the Pasadena Avenue to Arnold Street project is the Vinnell Corporation, Vinnell Constructors and A. S. Vinnell Company. Kaiser Steel Corporation fabricated and erected part of the structural steel including the curved girders. Additional subcontractors for structural steel were the Vinnell Steel Company and the Bethlehem Steel Company.

For the general Contractor, Project Superintendent is Robert Hayden and Bridge Superintendent is Al Thronson.

Big Bear Loop

New 16-Mile Highway Opens Up Large Scenic Recreation Area

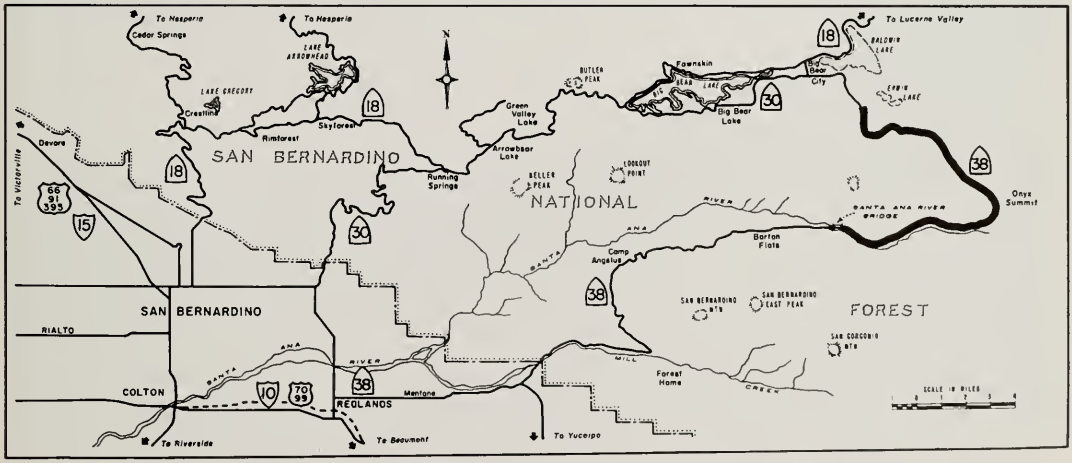


Completion of a 16-mile paving contract in July has opened up for scenic and recreational travel a large area of the San Bernardino National Forest, previously inaccessible by public road. The area lies in the upper reaches of the Santa Ana River watershed. Frequently referred to as the "Barton Flats to Big Bear Loop", the new section of highway closes a gap which has prevented direct connection between the popular mountain resort areas on either side of the river.

Construction of the new road was accomplished under several contracts administered by the U.S. Bureau of Public Roads. The U.S. Forest Service and the California Division of Highways participated in financing and in acquisition of right of way over private lands. The highway is a part of the State Highway System, and will be maintained by the State. In recognition of the importance of this new link in the system, the highway from



Opening ceremonies for the new section of the Big Bear Loop highway (State Sign Route 38) were held at Onyx Summit on August 12.



The heavy black line on the above map shows the location of the new section of highway on the Big Bear Loop.



A view of the new highway during construction showing a paving plant in operation to the left of the roadway.



A view of the new highway and surrounding country shortly before it was opened to the public.



Traffic posses over the new section of Sign Route 38 following opening ceremonies on August 8.

Redlands through Camp Angelus and the Barton Flats area, and over the new section to Big Bear City, has been designated State Sign Route 38.

Highway Connections

Motorists desiring a mountain loop trip, mostly above the 6000-foot level, will find connections to Highway 38 at Orange Street in Redlands, or they may make connections with Highway 18 (Rim-of-the-World Highway) in San Bernardino; with Highway 30 (City Creek Road) near Highland; or with Highway 18 in the Apple Valley-Lucerne Valley area. The new Highway 38 will be marked by large signs on the U.S. 70-99 (Interstate 10) freeway now under construction through Redlands.

Construction of the 16-mile link was started in June 1959, with a contract by Spirite and Cohn for grading five miles eastward from South Fork Camp and constructing the Santa Ana River Bridge. R. W. Ellis was Resident Engineer for the U.S. Bureau of Public Roads on this contract. The second unit consisted of grading the remaining 11 miles, under two contracts with J. E. Haddock, Ltd. J. M. Hawkins of the U.S. Bureau of Public Roads was Resident Engineer. The final unit, paving the entire 16 miles, was completed by Osborn Company in July 1961. Resident Engineers on this contract were F. J. Clavert and J. J. O'Neill.

Camps Are Planned

Onyx Summit, where the new road crosses from the Cienega Seca watershed to the Big Bear Lake watershed, is at elevation 8451. Maximum grade rate is 6%, providing a high gear, two-lane mountain road with excellent visibility and alignment. The U.S. Forest Service plans to develop recreational camps and facilities, similar to the Barton Flats area, at several locations along the new highway. This section of highway was declared a freeway by the California Highway Commission and rights of way with controlled access were acquired, which will preserve its ability to move traffic safely and expeditiously.

Barrier Report

Performance of Beam, Cable Types Analyzed

By KARL MOSKOWITZ and WILLIAM E. SCHAEFER, Assistant Traffic Engineers



Beam barrier on a heavily-traveled section of the Nimitz Freeway in Alameda County.



The cable barrier section on the Nimitz Freeway near San Leandro.

In the summer of 1959, two types of median barriers were developed and tested for use on California freeways. These were the cable-chain-link fence barrier, hereafter referred to as "cable", and the double-blocked-out metal beam barrier, hereafter referred to as "beam".

Details of the barriers, and tests leading to their adoption, were reported in "California Highways and Public Works" in July-August, 1959. The photographs on this page show typical installations of both types.

The status of the current barrier construction program is as follows:

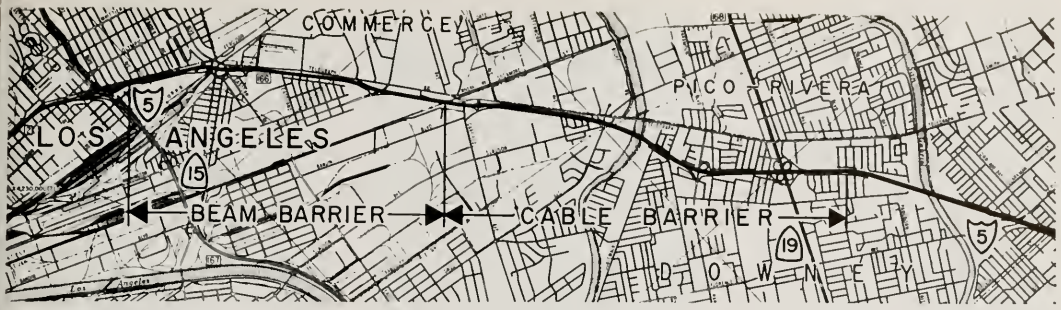
	Net Miles of Barrier-Divided Highway		
	Cable	*Beam*	*Total*
Constructed	31.5	16.8	48.3
Under Construction	47.0	15.1	62.1
Budgeted	38.5	11.6	50.1
Total	117.0	43.5	160.5

The maps, Figures A and B, show the locations of barriers constructed or budgeted.

In order to compare the performance of the two types of barrier, the first contracts were split, with some of each type in each contract. These are referred to as test sections. One test section was on the Santa Ana Freeway in Los Angeles County where 3.17 miles of cable barrier were erected end-to-end with 2.57 miles of beam barrier; the other test section was on the Nimitz Freeway in Alameda County where 3.87 miles of cable barrier were erected end-to-end with 2.87 miles of beam barrier. Before-and-after accident records on these test sections have been examined. The results of the study are given in this report.

Summary

(1) Head-on accidents were virtually eliminated by the barriers. On the Santa Ana and Nimitz test sections, there were 49 cross-median accidents in the "before" period, including eight fatal accidents, compared with



A map of the test section on the Santa Ana Freeway in Los Angeles County where 3.17 miles of cable barrier were erected end-to-end with 2.57 miles of beam barrier.

two cross-median accidents in the "after" period, one of which was fatal.

(2) Total accidents and injury-accidents increased in the locations where barriers were installed. (However, there were eight fatal accidents in the after-period as compared with a total of 12 in the before-period.)

(3) The freeway test sections with the cable barrier experienced a smaller increase in the overall accident rate than did those with the beam barrier. There was no proof that the accidents involving the cable barrier were less severe. However, the findings of the impact tests indicated that in high-speed collisions the cable barrier would result in much less severe injury to vehicle occupants and it is believed that in the long run the accidents involving the cable barrier would be less severe.

(4) A sports car has gone through the cable barrier and two vehicles have gone over it. It is expected that the current new series of crash tests will solve the problem of vehicles going over this barrier.

(5) The maintenance cost of the cable barrier is considerably higher than that of the beam barrier. First cost of the beam barrier is much greater than the cable barrier.

(6) More accidents involve the cable barrier, but the proportion of single-vehicle accidents is much higher with the cable barrier than with the beam barrier. There is no indication that drivers are more reluctant to swerve into the beam barrier, but there are indications that there may be more "hit-and-drive-away" accidents involving the cable.

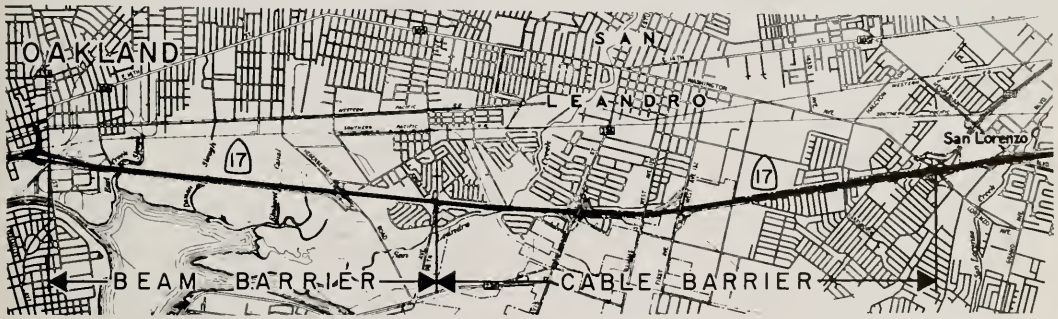
(7) There was little difference in the barrier accident rate between the sections with 12- and 22-foot medians, and the maintenance cost per mile was essentially the same. The crash tests showed that the cable barrier could deflect or give under impact—allowing a vehicle to momentarily enter the opposing lanes. However, nothing in the study indicated this to be a problem.

I. EFFECTIVENESS OF BARRIERS IN PREVENTING CROSS-MEDIAN ACCIDENTS AND FATAL ACCIDENTS

Both types of barrier have proved effective in accomplishing the purpose for which they were designed. They have been struck hundreds of times, and only two headon accidents have occurred at locations where they are in place. Two vehicles climbed or jumped clear over the barrier. A new series of crash tests, using heavier vehicles and 75 mile per hour speeds (instead of the 60 mile speeds used in the original tests) are now under way in an effort to make the design even more fool-proof.

II. EFFECT OF BARRIERS ON OVER-ALL ACCIDENT RECORD, BY TYPE OF BARRIER

As described in the introduction, test sections of both types of barrier were erected on the Santa Ana Freeway and the Nimitz Freeway for the purpose of comparing the effectiveness of the two types of barrier.



A map of the test section on the Nimitz Freeway in Alameda County where 3.87 miles of cable barrier were erected end-to-end with 2.87 miles of beam barrier.

Although there is no way of being sure that the differences between sections are attributable solely to the difference in type of barrier, it was thought that as many extraneous factors as possible would be eliminated by an end-to-end comparison on the same freeway where traffic volume remains approximately uniform, and where, in fact, the very same vehicles pass by first one type of barrier and then the other.

Comparisons between cable barrier on one freeway and beam barrier on another should be interpreted very cautiously, because there are so many other potential variables which could affect accident rates that the difference owing to type of barrier can be smothered in irrelevancies.

The Santa Ana test sections were between the Long Beach Freeway and Buhman Avenue, and the Nimitz Freeway test sections were between High Street and Washington Avenue. These are both 6-lane freeways with 12-foot medians. The average daily traffic was between 90,000 and 100,000 on all sections. Grades are practically level and alignment is excellent.

Before-and-after statistics, using one year prior to construction as the "before" period, and one year after completion as the "after" period (the period during construction is omitted) are shown in Table 1 for the Santa Ana test sections, Table 2 for the Nimitz test sections, and Table 3 for a section of the Hollywood Freeway.

The following points are noted concerning the Santa Ana test sections:

(1) Before barriers were erected on either section, the section where beam barrier was later erected had a much lower accident rate than the section where the cable barrier was erected.

(2) The total accident rate increased significantly after erection of the barriers, on both sections.

(3) The percentage increase on the section with the beam barrier was very much greater than the percentage increase on the section with the cable barrier.

(4) Although total reported accidents increased where the cable barrier was installed, accidents severe enough to cause injuries did not increase. Where the beam barrier was installed, the injury accident rate increased by 53%. This increase cannot be directly related to cars which crashed into the barrier, however.

The following points are noted concerning the Nimitz test sections:

(1) The over-all accident rates were about equal on both sections before the barriers were erected on either section.

(2) The accident rates increased significantly after erection of the barriers, on both sections.

(3) The increase in accident rate was somewhat greater on the beam section than on the cable section (37% against 26%).

(4) During the "after" period, 42% of the reported accidents on the cable section resulted in injuries, and 44% of the reported accidents on the beam section resulted in injuries. This is about the normal ratio for all freeways.

The following points are noted regarding the Hollywood Freeway beam barrier installation:

(1) The rates were high * before and after. This is probably characteristic of extremely congested freeways.

(2) The barrier did not affect the rates, either over-all or injury.

* While these rates are considered high for urban freeways, they are still only about ⅓ of the rate on urban arterials other than freeways.

TABLE 1

BEFORE AND AFTER RECORD—SANTA ANA FREEWAY TEST SECTIONS

All Reported Accidents

		Before		*After*		*Change*	
	Miles	*No.*	*Rate * per MVM*	*No.*	*Rate per MVM*	*in Rate*	*Percent*
Cable	3.17	120	1.08	153	1.30	+0.22	+20
Beam	2.57	74	0.80	107	1.12	+0.32	+40

Injury-Accidents (Including Fatal)

		Before		*After*		*Change*	
	Miles	*No.*	*Rate per MVM*	*No.*	*Rate per MVM*	*in Rate*	*Percent*
Cable	3.17	55	0.49	56	0.48	−0.01	−2
Beam	2.57	26	0.28	41	0.43	+0.15	+53

* Rate per MVM is the number per million vehicle-miles. An injury-accident rate of 0.49 per MVM shows that more than two million car-miles (the total life of about 30 cars) of travel are accumulated for each accident serious enough to cause minor injuries to the occupants.

TABLE 2

BEFORE AND AFTER RECORD—NIMITZ FREEWAY TEST SECTIONS

All Reported Accidents

		Before		*After*		*Change*	
	Miles	*No.*	*Rate Per MVM*	*No.*	*Rate Per MVM*	*in Rate*	*%*
Cable	3.87	185	1.51	250	1.90	+0.39	+26
Beam	2.87	146	1.55	216	2.13	+0.58	+37

Injury-Accidents (Including Fatal)

		Before		*After*		*Change*	
	Miles	*No.*	*Rate Per MVM*	*No.*	*Rate Per MVM*	*in Rate*	*%*
Cable	3.87	71	0.58	105	0.80	+0.22	+38
Beam	2.87	*	*	95	0.94	*	*

* Where the beam barrier was installed, there was a change in jurisdiction of enforcement agencies between the "before" and "after" periods. Because of a change in methods of reporting, and in definition of "injury", the injury-accident rate in the before period is not known.

TABLE 3

BEFORE AND AFTER RECORD—HOLLYWOOD FREEWAY BETWEEN HARBOR FREEWAY AND BENTON WAY

Beam Barrier 1.68 Miles—ADT = 190,000

	Before		*After*		*Change*	
	No.	*Rate*	*No.*	*Rate*	*Rate*	*%*
All Accidents	242	2.10	266	2.21	+0.11	+5
Injury Accidents	158	1.37	155	1.29	−0.08	−6

(3) The ratio of injury accidents to total accidents, 60%, is very high. It is possible that many non-injury accidents are being overlooked on this section.

Before-and-after studies were also made on four other short installations of beam barrier, two on the Santa Ana Freeway near the East Los Angeles Interchange, and two on the Bayshore in San Francisco.

Because of a change in reporting methods on the Bayshore, and because of construction operations and other modifications of the freeway on this portion of the Santa Ana, reliable before-and-after comparisons cannot be made. Available records on three of the sections showed an apparent increase in accidents, and one section, between Soto Street and the San Bernardino Freeway junction on the Santa Ana, showed a large apparent decrease. The latter section comprised many short sections of barrier intermittent with previously existing retaining walls and other median obstructions.

The barriers have generally resulted in an increase in over-all accidents, except on the Hollywood Freeway where the volume is 190,000. An earlier study * had indicated that barriers would increase accidents on roads where the volume is less than 130,000.

The percentage increase in both the all-accident rate and injury-accident rate was greater where the beam barrier was placed than where the cable barrier was placed, although the sample is so small and other unaccounted-for differences in rates are so large that these differences could be due to reasons other than difference in barrier types.

It may be significant that the rise in accidents on the cable barrier section of the Santa Ana was not accompanied by a rise in the injury-accident rate. However, the rise in injury accidents on the Nimitz cable section was just as great as the rise in all-accidents on this section.

The ratio of all-accidents to injury-accidents lies in the expected range of 2.2 to 2.8 in the before and after samples for both types of barrier in the test sections. This is significant in that it shows that the increase in reported accidents is not composed of mere "fender-benders" or "fence-scrapers."

* "Median Study" (Calif. Highways & Public Works, July-Aug. 1959).



A close-up showing construction detail of o blocked-out beom barrier on the Santa Ana Freeway.

III. ACCIDENTS INVOLVING THE MEDIAN

A. Although head-on accidents were virtually eliminated by both types of barrier, it has been seen that in general there was a rise in accident rates where the barriers were installed on freeways having traffic volume less than 130,000 vehicles per day. One explanation, of course, would be that without a barrier many vehicles are able to encroach on the median without suffering a reportable accident, whereas after the barriers are installed, they strike a barrier. Table 4 shows the relation between the number of cars hitting the barrier and the rise in accidents when barriers are installed.

It can be seen in Table 4 that a considerable proportion (57% to 80%) of the increase can be accounted for by collisions with the barrier except in the case of the Santa Ana Beam Section. Before reaching any conclusions, note that the over-all increase in the accident rate on the Santa Ana beam section was 50% greater than the increase on the Santa Ana cable section. The decrease in rate of accidents involving the median on the Santa Ana beam section is one of the inexplicable things that are frequently encountered when making a statistical study involving small numbers.

B. Events associated with barrier collisions: As Table 4 shows, a lot more drivers are getting involved with the median than there were before the barriers were erected. What the table does not show is the number of times the median was violated in the "before" period with no resulting accident.

There has been speculation that people are deliberately driving into the cable barrier on the theory that it is softer than the car ahead. In an effort to explore this possibility, Table 5 was prepared. This table classifies the accidents involving the barrier according to events preceding the collision. There is also a subjective classification in the right-hand two columns as to whether the vehicle was deliberately or involuntarily driven into the barrier. This classification represents the analyzer's judgment, based upon reporting officer's opinions, statements by the drivers, and statements of witnesses, as well as upon the events.

The following points are noted regarding Table 5:

(1) On the test sections, 58 percent of accidents involving the beam bar-

TABLE 4

PROPORTION OF INCREASE IN ACCIDENT RATES ACCOUNTED FOR BY ENCROACHMENT IN MEDIAN

	Over-all Increase in Accidents	*Accidents "Involving" Median*			*Portion of Increase Accounted for by Accidents Involving the Median*
		Before	*After*	*Increase*	
	Rate Per MVM	*Rate Per MVM*	*Rate Per MVM*	*Rate Per MVM*	
Santa Ana Cable	0.22	0.17	0.33	0.16	73%
Santa Ana Beam	0.32	0.23	0.15	(0.08)[D]	0
Nimitz Cable	0.39	0.22	0.53	0.31	80%
Nimitz Beam	0.58	0.19	0.52	0.33	57%

()[D] = Decrease



This photo shows a section of the beam barrier as it was being installed on the Santa Ana Freeway last February. Note the portion of partly completed barrier at the lower left.



Division of Highways maintenance workers repair a damaged cable barrier on the Santa Ana Freeway.

rier were 2-or-more-car accidents, whereas only 39 percent of accidents involving the cable barrier were 2-or-more-car accidents. On the Ventura Freeway, only 20 percent involved more than one vehicle.

(2) About one-fifth of the median barrier collisions were deliberate, a sort of "fielder's choice", in which the driver thought he was choosing the lesser consequence. This ratio was the same for the cable barriers as it was for the beam barriers, although on the Ventura Freeway only two "deliberate" swerves resulted in reported accidents. This freeway has eight-foot paved shoulders in the median, whereas the test sections on the Santa Ana and Nimitz Freeways have curbs and only a six-foot half-width.

(3) On the test sections, 86 percent of collisions with the beam barrier and 55 percent of collisions with the cable barrier were associated with maneuvers such as rear-end and sideswipe collisions or near-collisions.

(4) On the test sections, 22 percent of the cable barrier collisions and four percent of the beam barrier collisions were due to erratic driving, drifting, and unknown reasons. "Erratic Driving" are cars which were observed by witnesses to be driving erratically for some time before colliding with the barrier.

(5) "Unknown, miscellaneous, drifting, and sleep" accidents (nearly all involving only one car) accounted for 19 of the 26 collisions with the cable barrier on the Ventura Freeway. This relatively high proportion is due more to a lack of other kinds than to an excessive number of these kinds. The fact that there were only 7 accidents associated with rear-end and sideswipe maneuvers is probably attributable to the shoulders and absence of curbs.

It was also determined that 16 of the 26 on the Ventura Freeway were at night.

C. Repeated crash tests demonstrated conclusively that when a car collides with the cable barrier there is far less shock than with the beam barrier and that there should be far fewer injuries for a given number of barrier collisions. The first year's experience on the test sections showed the following:

TABLE 5

MEDIAN BARRIER ACCIDENTS CLASSIFIED BY ASSOCIATED EVENTS

(One Year After Construction)

(Test Sections and Ventura Freeway)

			Avoid Read-end Accidents		*Unsafe Lane Change*		*Knocked Into Barrier by*		*Ran Into Barrier After*			*Drifted Into Barrier (Sleep, Drink, Inattention)*					
	Single Vehicle	*Multi-Vehicle*	*Deliberate Action*	*Lost Control*	*Avoiding*	*Making*	*Side-swipe*	*Rear-end*	*Side-swipe*	*Rear-end*	*Erratic Driver*		*Misc.*	*Unknown*	*Deliberate Action*	*Involuntary Action*	*Total Accidents*
CABLE-CHAIN LINK BARRIER																	
Santa Ana	23	15	8	2	2	1	3	1	1	3	2	2	8	5	11	27	38
Nimitz	37	23	5	12	8	0	2	5	0	1	8	3	14	2	11	49	60
TOTAL {No.	60	38	13	14	10	1	5	6	1	4	10	5	22	7	22	76	98
TOTAL {%	61	39	13	15	10	1	5	6	1	4	10	5	23	7	22	78	100
Ventura	21	5	2	0	1	0	2	2	0	0	1	5	4	9	2	24	26
BLOCK-OUT METAL BEAM BARRIER																	
Santa Ana	5	7	1	5	2	1	1	0	0	1	0	0	0	1	2	10	12
Nimitz	16	22	7	11	5	0	2	5	0	2	0	1	5	0	10	28	38
TOTAL {No.	21	29	8	16	7	1	3	5	0	3	0	1	5	1	12	38	50
TOTAL {%	42	58	16	32	14	2	6	10	–	6	–	2	10	2	24	76	100

It is noted that experience of one year does not show conclusively that collisions with the cable barrier are less severe than with the beam. This is contrary to expectation. Observations and actual measurements of test crashes showed that deceleration rates, which are closely related to injury potential, are significantly less with the cable. There were so few serious injuries involving collisions with either type that it is believed that the measured evidence of physical tests outweighs the statistical evidence, in which chance plays a major part.

Maintenance records show that the number of repairs of the cable barrier greatly exceeds the number of reported accidents involving the barrier. On the other hand, there have been reported accidents involving the beam barrier that did not require repairs.

TABLE 7

COMPARISON OF REPORTED ACCIDENTS WITH BARRIER REPAIRS

	Reported accidents involving barrier	*No. of repairs*
Santa Ana Beam	12	25
Santa Ana Cable	38	60
Nimitz Beam	38	37
Nimitz Cable	60	91

TABLE 6

SEVERITY OF REPORTED ACCIDENTS INVOLVING MEDIAN BARRIERS

	Total No. of vehicles colliding with barrier	*Collisions in which occupants were injured*			*Fatal accidents*	
		Seriously	*Minor wounds, contusions*	*Total*	*No.*	*Remarks*
Santa Ana Beam	12	0	3	3	0	
Santa Ana Cable	38	3	9	12	1	x-median, head-on
Nimitz Beam	38	7	11	18	2	1 suicide, 1 truck driver ejected when truck hit barrier
Nimitz Cable	60	8	19	27	2	1 motorcycle, 1 spinning car, occupants ejected

Table 7 shows that collisions were much more likely to damage the cable barrier, and that for a given number of reportable accidents there is more disruption to traffic caused by barrier repairs, as well as additional maintenance cost. It does not necessarily show that there were more "drive-away" or hit-and-run collisions with either type, but it does show definitely that about one-third of the collisions with the cable barrier were so minor that the vehicles were able to drive away.

IV. CONSTRUCTION AND MAINTENANCE COSTS

A. *Initial Cost.* By the end of the 1960-61 fiscal year, approximately 49 miles of barrier had been installed. Average unit prices for the barriers were as follows:

	Per lineal foot	*Per mile*
1. Single Metal Beam	$5.84	$30,700
2. Double Metal Beam	8.31	43,800
3. Double Metal Beam on Steel Posts (Structures)	14.53	
4. Cable-Chain Link	3.25	17,100

The unit price of beam barrier was 2.6 times that of the cable barrier. In later contracts, the unit prices of cable barriers have declined.

Maintenance Costs

Maintenance costs of the two types of barrier during the one-year period after construction are shown in Table 8. The average yearly cost of repair is shown in terms of cost per mile, cost

per accident, and cost per million vehicle-miles of travel or exposure. The unusually large cost per mile for the beam barrier on the Nimitz Freeway was due to the two accidents involving truck-trailer combinations.

The annual cost per mile of $2,078 for the cable barrier was 2.9 times the $720 per-mile cost of the beam barrier. With a $1,358 per-mile difference in the annual cost of barrier repairs, it requires 19½ years for the damage cost of the fence barrier to equal the difference in construction cost between the two barriers. However, it should be noted that approximately 60% of the damage costs have been recovered, hence the actual difference in the maintenance costs to the State was $540 per mile.

At $540 per mile per year, it would require 49½ years to make up the difference of $26,700 per mile in initial cost.

More important than cost is the hazard to both maintenance workers and the traveling public of continual maintenance in the median. There is also a certain amount of congestion caused by such operations. In this regard, comparison of the two types should include the bulkiness of equipment and size of crew required, and the time per job, as well as the number of repairs required. The width of median is also important in this respect.

TABLE 8

COST OF BARRIER REPAIRS FOR ONE YEAR AS REPORTED BY MAINTENANCE DEPARTMENT

Cable Chain Link Barrier

Freeway	*Length*	*Million Vehicle-Miles*	*No. of Repairs*	*Total Cost (One Year)*	*Cost Per Repair*	*Cost Per Mile-Year*	*Cost Per MVM*
Nimitz	3.87	131.65	91	$6,879.53	$75.60	$1,777.66	$52.26
Santa Ana	3.17	117.21	60	7,848.16	130.80	2,475.76	66.96
Sub-Total	7.04	248.86	151	14,727.69	97.53	2,092.00	59.18
Ventura	2.35	78.06	43	4,782.00	111.21	2,034.89	61.26
Total	9.39	326.92	194	$19,509.69[1]	$100.57	$2,077.71	$59.68

Blacked-Out Metal Beam Barrier

Nimitz	2.87	101.30	37	$3,658.41	$98.88	$1,274.71	$36.11
Santa Ana	3.29	127.66	21	1,205.26	57.45	366.20	9.50
Sub-Total	6.16	228.96	58	4,863.67	83.90	780.00	21.25
Bayshore	1.43	53.42	4	599.88	149.97	419.50	11.23
Total	7.59	282.38	62	$5,463.55[1]	$88.10	$720.00	$19.35

[1] Approximately 60% of this was recovered from vehicle owners whose cars damaged the barrier.

Scope of Report

This report covers a limited amount of experience which has been had during the year following initiation of the barrier construction program. Although there are indications regarding the effectiveness of the barriers, both in preventing cross-median head-on collisions and in increasing over-all accident rates, the experience so far should be interpreted with caution and only tentative conclusions should be made at this time. Additional data are being accumulated covering more extensive sections of barriers over a greater period of time. It is planned to continue the investigation. In the meantime, barriers are being installed on all 8-lane freeways and on freeways where the average daily traffic exceeds 60,000 per day. It has been shown in the 1959 study and confirmed by 1960 experience that four-fifths of all the cross-median, head-on fatal accidents occur on these high-volume freeways.

A report on the current series of crash tests which are being made to improve present designs will be published in "California Highways and Public Works" magazine in the near future.

According to law, $5,000,000 in state highway matching funds is made available each year by the Highway Commission to help finance local grade separation projects included on an annual priority list established by the State Public Utilities Commission.

Department Members Win 25-Year Awards

Headquarters Office
Charles Cordero
Amy Aileen Jones

District I
Emery L. Blomquist
Joe O'Connell
Richard H. Ramsey
Howard E. Raymond

District III
Herbert M. V. McAllister

District IV
John A. McCrea

District V
Edwin J. Eggler
John L. Slaughter

District VI
Harry James Gazzola
J. Howard Lang

District VII
Byron L. Green
Lloyd B. Hughes
Ralph Palmer
Lan M. Weir

District VIII
Joe C. Cordery
Henry E. Sandoz
Roscoe Webb

District IX
F. B. Thrailkill

District X
Kenneth N. Hatch
Hazel Laughton
F. J. Leithold
Melvin B. Rowan

Bridge Department
Irwin W. Black
Darwin C. Dinsmoor

Materials and Research Department
William S. Maxwell

Shop 3
George W. Hayes

During August cloudbursts and resulting flash floods closed several sections of state highways in southern California until mud and other debris could be cleared from the roadways.

Watt Avenue

1½-mile F.A.S. Job Includes Bridge, U.S. 50 Connection

By D. W. McKENZIE, Chief, Highways and Bridges Division, and
F. T. WALDECK, Resident Engineer, Sacramento County

Immediately following dedication and ribbon-cutting ceremonies July 21, a major milestone was reached



PROJECT LOCATION
WATT AVE. EXTENSION

SCALE IN MILES
1 0 1 2 3

in the development of Sacramento County's highway network when traffic for the first time was turned onto the new Watt Avenue Extension two miles east of Sacramento.

A portion of Federal Aid Secondary Route 933, the Extension commences at Fair Oaks Boulevard and travels 1.5 miles south, across the American River, and connects with U.S. 50, as shown on accompanying maps.

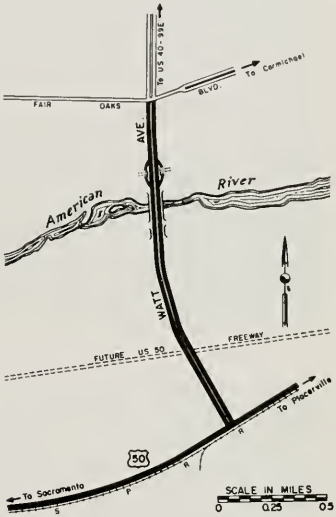
The expressway is an integral part of the official Master Plan of Streets and Highways of Sacramento County, and in this booming metropolitan area is a vital link between the vast residential section north of the river and the industrial and defense on the south.

Following a previously unconstructed route, the four-lane divided facility was built over a period of one year and eight months under four separate contracts totaling nearly $1,500,000. Of this total cost, $742,000 was involved in two FAS projects and $749,500 in two county-financed jobs.

It is the only river crossing between the City of Sacramento and Citrus Road ten miles to the east. Its effectiveness became immediately apparent as predicted. One month after being placed in service, the route was carrying 13,000 vehicles a day—mostly commuters who formerly used the other two widely separated routes.

Crosses Future U.S. 50

The Extension also crosses the adopted alignment of the future U.S. 50 freeway which will run east and west about one-half mile north of the existing state highway.



PROJECT LOCATION
WATT AVE. EXTENSION

The overall four-stage improvement included 1) a four-lane divided bridge



The new Watt Avenue Bridge across the American River. The small bridge in front is privately owned.



One set of footings for parallel pier columns on the bridge shown just after stripping the forms.



This photo, taken during the construction of the bridge, shows the re-usable, prefabricated pier forms still in place on the two front piers.

over the river, 2) a four-lane divided grade separation structure with a diamond interchange located 1,000 feet north of the bridge, 3) a similar structure for a future ½-cloverleaf approximately 400 feet south of the bridge, and 4) the four-lane roadway. The final highway project also included 1.5 miles of divided road from Fair Oaks Boulevard north to Arden Way. This final contract was accepted from the contractor August 18.

Terrain through which the Extension passes is flat. However, due to levees and necessary structure clearances, a maximum grade of 4 percent was necessary. Minimum radius of curve on the main line is 1,800 feet. Right of way width is 150 feet, except that within 600 feet of Fair Oaks Boulevard, where no fill exists, width is 100 feet.

Construction of the American River bridge was commenced December 3, 1959 by Lord & Bishop of Sacramento. It is actually two parallel reinforced concrete t-beam structures of 13 spans each and 1,012 feet long, providing clear roadway widths of 28 feet with a six-foot-wide raised divider between, and five-foot sidewalks with steel railings on the outside.

Water Level Low

Luck was with the contractor in the river work. Flow remained at a low elevation throughout construction, making cofferdam work for the piers routine. After foundation work was completed, the pier columns, being identical, were constructed with four sets of prefabricated forms, providing an efficient operation for erection of the 24 columns.

Placement of reinforcement for pier columns, whose height ranged from 18 to 46 feet, was accomplished by tying the required steel into cages and hoisting the cages into position. A similar technique was used in placing steel for the five-foot deep t-beams. The steel in this phase was tied for beams from hinge to hinge and lowered into position.

Placement of concrete was by standard methods. Piers were worked in pairs and brought up at the rate of five feet per hour. For t-beam and deck concreting, pours were monoliths extending from hinge to hinge,

varying in length from 154 to 280 feet, and in volume from 285 to 475 cubic yards. By employing independent screed supports for finish grade and vibratory strike-off for deck finishing, the contractor was able to obtain a smooth-riding surface.

Limitations set up in the Special Provisions, relative to stripping falsework in adjacent spans, made it desirable for the contractor to prefabricate forms for 500 feet of bridge. This method required continuous construction in order to finish the project within the 269-working-days limit.

Quantities Listed

Quantities for major items of work included 2,100 cubic yards structure excavation, including wet excavation; 5,400 cubic yards Class A concrete; 700 tons steel reinforcement; 329 steel piles with a total length of 9,400 feet; and 2,045 lineal feet steel railing.

Total value of the contract was $588,769 of which the Federal government contributed 58 percent, the State 37 percent, and the County 5 percent plus engineering and rights of way.

Work on the north Watt Avenue separation began March 23, 1960 under a contract with Thomas Construction Company of Fresno. Because of excellent supervision and scheduling of operations, the project was completed September 14, one month ahead of time.

The separation is an undercrossing for a future highway to serve the Haggin bottom land area. It consists of a pair of similar parallel reinforced concrete slab bridges, each with four spans and an over-all length of 145 feet. Providing clear roadway widths of 34 feet each plus a six-foot raised median, the structures are supported on concrete columns and open abutments which are supported on concrete piles. The four ramps forming the diamond interchange were added later by the County.

Provides for Future Road

Like the north separation, the south Watt Avenue separation is an undercrossing for a future road and will include a half-cloverleaf interchange. It, too, is a pair of parallel concrete slab bridges. Their location in the



BEFORE—Looking north up Watt Avenue prior to construction. The intersection in the center is with Fair Oaks Boulevard. The bridge (foreground) is privately owned.



AFTER—The completed Watt Avenue Bridge and freeway section looking south toward U.S. 50. The structure immediately beyond the bridge will be part of an interchange to serve a proposed housing development on the south side of the river.



The completed bridge shortly after it was opened to traffic. The view is north toward the Fair Oaks Boulevard intersection.

alignment required that they be constructed on a 2,000-foot radius curve with a 4 percent superelevation—the only variation from the north separation in basic design.

Work was started September 23, 1960 by Leedham & Roebbelen of Sacramento and was completed within the 140 working days allowed. The value of contract work was $152,510 which was totally financed by the County.

This spring, the final operation in the linking of Fair Oaks Boulevard and U.S. 50 got under way when A. Teichert & Son, Inc. of Sacramento began work on the grading and paving contract valued at $596,966. This job, too, was financed entirely by Sacramento County. It also included four-laning Watt Avenue from Fair Oaks Boulevard north to Arden Way, about 1.5 miles.

Prior to the project, Watt Avenue existed from Fair Oaks north as a two-lane road on a right of way varying from 70 to 106 feet. For about 1,300 feet there was a frontage road along the west side; about 3,700 feet on the east side; and another 1,400 feet of frontage road on both sides. These local roads had curb and gutter on the property side, but no sidewalks.

Sidewalks Installed

The County planned to construct the divided four-lane facility within the existing right of way by eliminating these frontage roads. This plan caused considerable opposition from abutting residents who wanted to retain the frontage roads as a refuge for their children from the main stream of traffic.

After several meetings the issue was compromised. The County agreed to install sidewalks for school children's safety to replace the frontage roads.

The highway north of Fair Oaks Boulevard was constructed as four 12-foot lanes with 10- to 16-foot shoulders plus a 14-foot curbed median with left-turn lanes at 11 of the 22 intersections. The median was continued across 11 less important intersections and eliminated many left-turn movements.

As for the new section south of Fair Oaks Boulevard, one 3,300-foot portion between the south separation and U.S. 50 was built four-lane undivided on a "detour" alignment. Although it is not obvious to motorists, this portion is actually located a sufficient distance west of the permanent alignment to permit the State to build a future interchange that will carry Watt Avenue over the ultimate U.S. 50 freeway without interfering with Watt Avenue traffic. Also, the State will save the cost of the detour which would otherwise be necessary—a typical example of the continuing cooperation between the State and County highway departments.

Major Items

Quantities for major items of work included 50,000 cubic yards roadway excavation; 30,000 cubic yards import; 53,600 tons aggregate subbase; 70,900 tons aggregate base; 22,440 tons asphaltic concrete; 8,000 linear feet curb and gutter; 25,000 linear feet curbing; and 27,000 square feet sidewalk.

The roadway excavation and unsuitable excavation figures represent an overrun of 22,000 and 10,000 cubic yards respectively. That was caused by the presence of a large amount of unsuitable material underlying the existing roadway between Fair Oaks Boulevard and Arden Way. It appeared that the muck, undetected prior to the contract award, had been deposited by an ancient slough that once coursed through the project alignment.

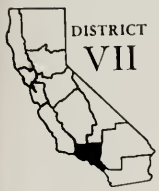
This project also included traffic-actuated signals at the U.S. 50 intersection. They were electrically interconnected with the system at U.S. 50 and Manlove Road, about 1,000 feet east. Both were then interconnected by radio to the master traffic control system for U.S. 50 in the vicinity of Mather AFB and Rancho Cordova.

All design construction engineering and inspection, both on the structures and road work, was performed by personnel from the Inspection and Surveys Division, Sacramento County Department of Public Works, A. L. Kiefer, Director. Representatives from the Division of Highways made frequent visits during construction of the two FAS structures.

L.A. Renaissance

Freeway Service Key Factor in Downtown Growth, Renewal

By MILTON STARK, Information Officer, District VII



The decision to remain on 12th Street between Broadway and Olive (in Los Angeles) was predicated on the conviction that this location represents the focal point of a dynamic new urban community that is growing along the axis between the new Civic Center and the cultural-recreational center represented by the University of Southern California, the Coliseum, Sports Arena and museums in Exposition Park.

Of equal significance in our study was the impact new freeways presently under construction will have on the future growth of downtown Los Angeles—especially the area between Olympic and Venice Boulevards. The new Santa Monica Freeway, which parallels Venice Boulevard and will cross the Harbor Freeway, will eventually complete a freeway loop around the downtown district. This loop will permit vehicles to have free and easy access to the southern perimeter of downtown without traveling through the interchange system.

The new freeway system will make Occidental Center immediately accessible from all sections of Greater Los Angeles—both by automobile as well as all forms of public transportation.

Grateful acknowledgments for assistance in the preparation of this article are extended to the Los Angeles Central City Committee, the Los Angeles City Planning Department, the Downtown Business Men's Association, and the architects and public relations departments of the agencies, organizations, businesses and institutions described herein.

BELOW—Looking west from the Harbor Freeway to the Union Oil Center Building. The verdure of the freeway landscaping blends gracefully with modern architecture. Big business planners recognize the utility of locating near a freeway.



The foregoing remarks were made by Horace W. Brower, President of Occidental Life Insurance Company of California, on the eve of groundbreaking ceremonies for the new $25,000,000 Occidental Center scheduled for September of this year. The company, which calculates its total assets in 1960 at $816,536,525 with $10,206,576,348 in policies in force, is expanding its national headquarters in Los Angeles. Occidental's consulting planners spent five years in the determination of the most advantageous location for the company's headquarters.

Implicitly significant in Brower's statement is the changing character of the Central City, a trend outward by business and industry and a trend inward by headquarters agencies and all of the consequent related improvements of new construction, renovation, restoration and slum clearance. It nowise means abandonment of downtown Los Angeles, but is rather a metamorphosis indicating growth and expansion. Termed broadly decentralization, the trend is given general definition and description in the ensuing discussion.

The prime mover in the renaissance of Los Angeles, particularly in the Central City area—which is roughly bounded by the Hollywood Freeway


NEW CONSTRUCTION 1945 – 1960
CENTRAL CITY AREA
CITY PLANNING COMMISSION – LOS ANGELES CALIF

to the north, the Santa Monica Freeway to the south, the Santa Ana Freeway to the east and the Harbor Freeway to the west—has been the trend to decentralization in concentric circles outward from the core of downtown. So that self-sufficient entities or communities are forming along expanding perimeters outside of the heart of the city, partly because of the growing network of freeways, which cut distance and time travel. This emigration, reflected in the general population decline in the old nucleus of the Civic Center and the shift of business and industry to serve further removed metropolitan centers, is also partly owing to a desire for suburban living, away from and independent of the Central City or downtown. Impetus to this movement is given by the steady influx of new residents into this part of Southern California and the problems of living and working space which they inevitably introduce.

Decentralization, then, is giving new character to the Central City. The nature of downtown is undergoing change towards a related net of headquarters offices, administrative and executive centers, forming a nucleus of entirely new developments designed to serve the far-flung metropolitan complexes. In this sense, the outlying communities are not independent but rather a loose federation connected to the administrative headquarters in the Central City.

For the immediate purposes of this discussion, the geographical area described is that of the Central Business District or the 400-acre core area bounded by First Street on the north, Los Angeles Street on the east, Olympic Boulevard on the south and the Harbor Freeway on the west. This, then, is the nucleus of the Central City. The Central City itself exceeds 6 square miles of land area and is framed by the Hollywood, Santa Ana, Santa Monica and Harbor Freeways.



Rejuvenation in Los Angeles does not neglect the natural beauty of trees and lawns. This is the new Public Health Building in Civic Center.

Land Value

An interesting comparison is had in the assessed value of land and improvements in the Central Business District for the sample years 1941-42 and 1959-60. In the former year, land was valued at $72,000,000 and improvements at $47,700,000; in the latter year land was set at $63,038,000 and improvements $85,100,000. A definite relationship is shown in the fall of land value and the rise of improvements over a 20-year period.

Floor Space

The Central Business District, which is largely comprised of office buildings, retail stores, hotels, institutional, governmental and quasi-public, manufacturing and wholesale, services and automobile parking, showed a rentable floor and ground space of 36,800,000 square feet in 1930, 38,200,000 square feet in 1955 and 40,500,000 square feet in 1960. The trend upward in useable space has been most evident in the years since 1945, 3,917,000 square feet having been added in the 15-year interim. In company with new construction during the 29 years spanning 1931 and 1960, a good deal of demolition was accomplished, amounting to 3,626,294 square feet; the net gain resulting from subsequent improvements is calculated at 1,577,000 square feet of floor space.

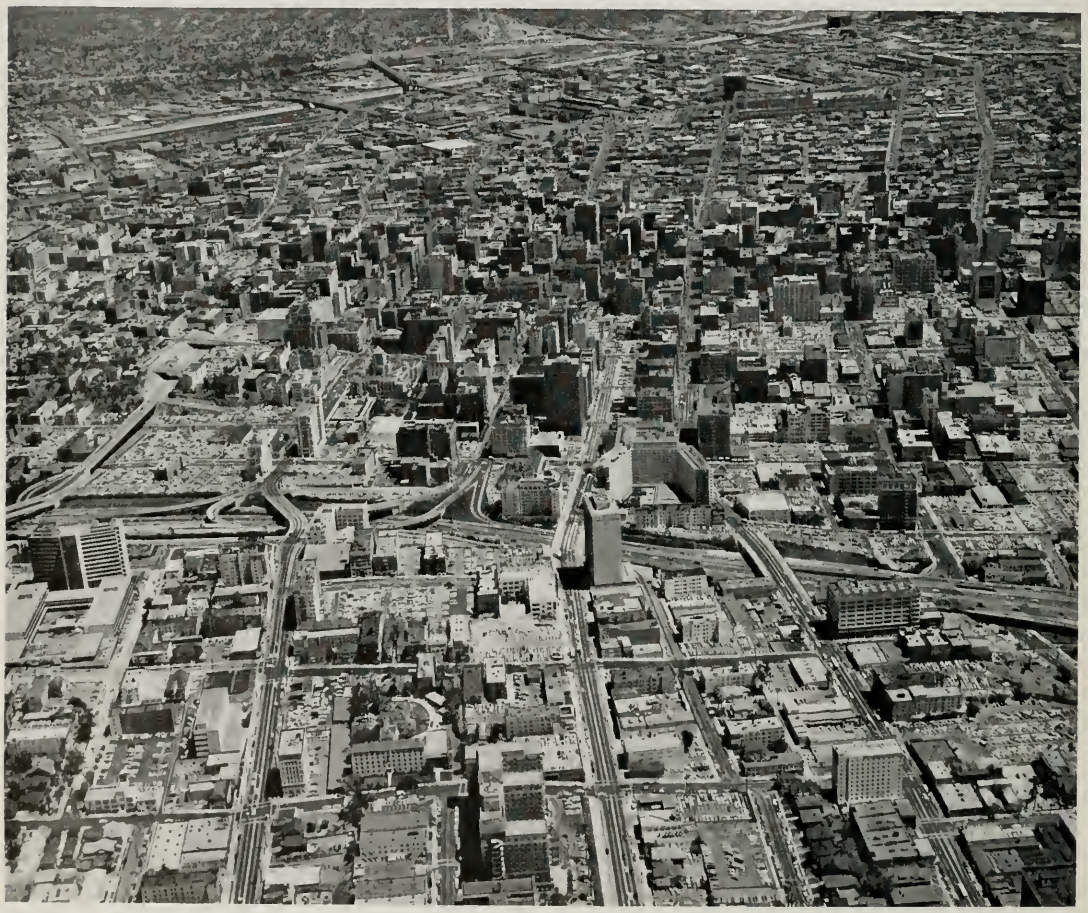
Sales

Retail sales of such diversified items as food, furniture, gasoline, lumber, apparel in the Metropolitan area (Los Angeles and Orange Counties) indicate in the grand total a substantial increase from $3,612,725,000 in 1948

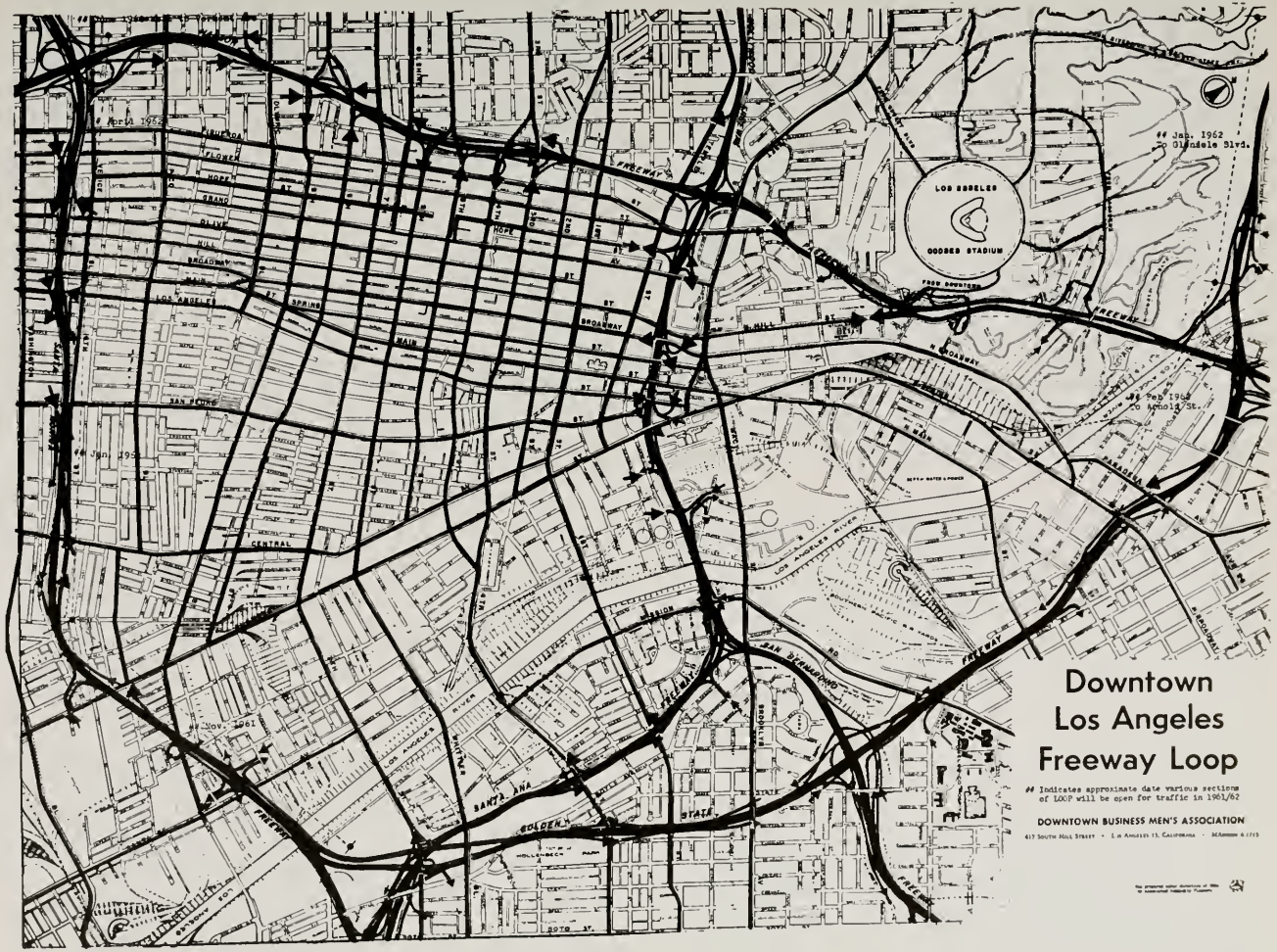
to $6,903,325,000 in 1954. On the other hand, within the Central Business District a decline is evident in total retail sales from $451,009,000 in 1948 to $421,003,000 in 1954. It is clear from these statistics that retail outlets, which in January, 1960 occupied 5,504,000 square feet of floor space, are burgeoning outward into the broader metropolitan area. It is significant that business follows the customer and during the last decade four department stores in the Central Business District opened thirteen branch outlets in the outlying areas. It is felt that with the growth of headquarters functions in downtown and the construction of multiple dwelling units on the periphery of the core area, downtown sales will be given new stimulus, though, certainly, they are substantial as they are.

Office Use

Office use has an important place in the Central Business District, occupying 32% of the available space. New office building construction is above the average for the U.S. as a whole, and the following figures are cited for the larger Los Angeles Metropolitan Area: In 1958 7.7% of total national construction and 29.5% in the West; in office building construction 12% of the nation and 40% in the West. In a four-year period between 1956 and 1959, valuation of new office buildings in the metropolitan area was set at $365,000,000 or equal to half of the New York area and equal to the combined areas of Chicago, San Francisco and Boston. The square footage added for the four years prior to 1960 for the entire Los Angeles Metropolitan Area is estimated at 18-25,000,000, including nearly 3,000,000 in the Central area and 750,000 in the Central Business District. Since 1948 a total of 14,000,000 square feet of office space has been added in Los Angeles City and 1,500,000 in the Central Business District.



An aerial view of the Los Angeles Central Business District looking east across the Harbor Freeway.



The above map shows the area of the city which will be encompassed by the Freeway Loop now under construction.

"Approximately fourteen million square feet of the office space constructed since 1948 has been located outside the Central Business District. However, of this amount an estimated 1,000,000 square feet was erected along the southwesterly and westerly fringe of the Central Business District within the past few years. Included are the structures of the Bank of America, Union Oil Company, Signal Oil Company, the Bar Association and the Pacific Clay Products Company. While directly outside the arbitrary boundaries of the Central Business District, the proximity of this development suggests that it properly should be considered as an integral part of the business district. The current inventory of office space in the Central Business District is approximately 12,424,000 net square feet. Approximately 85% of this space is contained in structures which were constructed before 1930. Many of these older buildings have been remodeled to provide modern accommodations. Many large one-firm buildings in the Central City Area house offices of petroleum companies and financial establishments. In aggregate, professional services regional in scope and other activities directly related to insurance, petroleum, finance, public utility or government administration activities, use the largest amount of Central office space."—Los Angeles Centropolis 1980, The Los Angeles Central City Committee and the Los Angeles City Planning Department.

Hotels

5,389,000 square feet of space is utilized by hotels in the Central Business District or 15% of floor space available in the area. Figures for 1956 show the presence of 26 hotels having a total of 10,000 rooms. More hotel and motel accommodations will be needed to keep pace with population influx and labor force increases in the Central Business District.

Floor Space Uses

An impressive array of statistics relating to other floor space uses and percentages have been compiled by city planners for the Central Business District and may be reduced to tabular form as follows: Manufacturing and Wholesale, 3,175,000 square feet, 8.8% of total floor area; Institutional (Churches, Clubs, Educational Eleemosynary) 2,070,079 square feet, 5.6% of total floor area; Government and Quasi-Public, 3,451,350 square feet, 10% of total floor area; Services (Financial institutions, travel agencies, restaurants, etc.), 2,449,775 square feet, 6.7% of total; Parking Structures, 1,305,229 square feet, Interior Parking, 921,900 square feet, Surface Parking, 3,737,071 square feet or a total of 31,000 parking spaces, 32.8% of total land area. The latter percentage is high and indicative of the popularity of motor vehicle travel over conventional public transit facilities.

1980 Needs

The population for the Los Angeles Metropolitan Area is estimated to reach 11,800,000 by 1980. As of July 1, 1961 it was 6,251,204.

"Space targets for the larger Central City area will depend in large measure upon the quantity and character of improvements planned for the inner core. The outer fringe will in all probability be devoted primarily to multiple apartment structures, the expansion of light industry, cultural facilities, and some of the smaller types of business services. Space targets for 1980 are predicated upon sweeping changes in the downtown, which will include the elimination of the blighting influences of previous years, and the introduction of a comprehensive improvement program. Should the downtown develop in accordance with its potential, an approximate doubling of the downtown daytime population is anticipated by 1980, a conservative expectation in view of the anticipated population growth and economic development of the region, the metropolitan area, and the corporate city. To achieve the expected doubling of the downtown daytime population, substantial increases in varying degree are anticipated in the downtown labor force, shoppers, business personnel and visitors. It is quite possible that the relative proportion of these several components might change during the process."—Los Angeles Centropolis, 1980, the Los Angeles Central City Committee and the Los Angeles City Planning Department.

Needs for 1980 as expressed by present estimates of future net square footage of floor space in the Central Business District are as follows: Retail, 5,917,000, Office Space, 24,145,000, Hotels, 7,080,000, Manufacturing and Wholesale, 2,500,000, Institutional, 3,658,000, Government and Quasi-Public, 4,000,000, Services, 4,366,000, Parking (interior), 5,500,000, (surface), 1,400,000.

The expected grand total of square feet for 1980 for the inner core of the Central City Area is 58,566,000. The square footage available today (1960) is 40,429,000. This means that new construction in the amount of about 18,000,000 must be added to achieve the goal, a goal which will be reached through reclamation, renewal and removal of outmoded structures.

Buildings—Developments
Occidentol Center

Ground-breaking ceremonies on the $25,000,000 Occidental Center, a complex of buildings including a 25-story tower on 12th Street between Hill and Olive Streets, will be held in September, 1961. Plans call for construction of a 9-story building on the northwest corner of 12th and Hill Streets, a 25-story tower adjunct on the northeast corner of 12th and Olive Streets, a 5-story parking structure with room for 700 vehicles, and remodeling of the present 9-story structure on 12th Street between Broadway and Hill Street. The finished complex will provide over 1,000,000 square feet of office space. Initial construction is scheduled for completion in January, 1963.

333 Building

Demolition is in progress to be followed by construction of a 35-story aluminum, glass and marble office skyscraper and 14-level parking structure at Sixth and Hill Streets overlooking Pershing Square. It will be called the 333 West Sixth Street Building, replacing the 40-year old Paramount Theatre Building, and will occupy one acre of land and have an area of 615,000 square feet. Valued at $20,000,000, the new development is scheduled for completion in the fall of 1962.

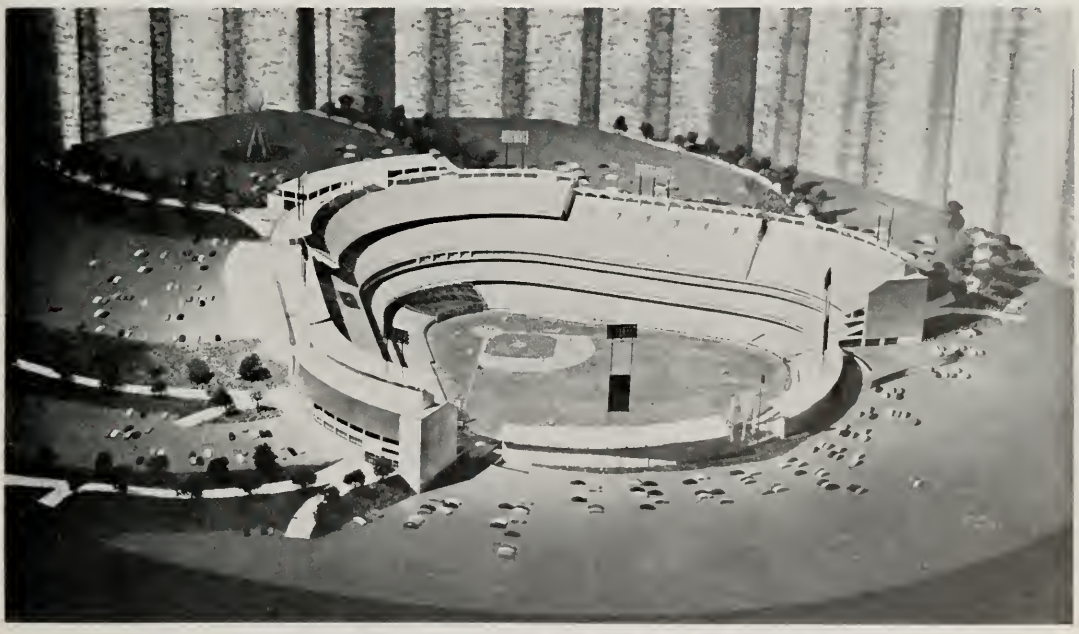
Construction of a 500-car electronic parking facility will employ a revolu-



A model of the future Occidental Life Building in the downtown area. (Photo by Herbert Bruce Cross.)



The proposed 35-story building at 333 West 6th Street. (Photo by Herbert Bruce Cross.)



A model of the new Los Angeles Dodger Stadium which will be constructed at Chavez Ravine.

tionary parking system consisting of aluminum crane elevator towers to whisk automobiles from ground level stalls to stalls on the highest level in 45 seconds. Fourteen high speed automatic passenger elevators will serve tenants and customers.

California Hospitol

In 1962 the Lutheran Hospital Society of Southern California plans expansion of a new $3,000,000 addition to the present facility at 1414 South Hope Street. The new wing will provide 119 beds with enlarged major and minor surgery facilities and a new cancer research and treatment program which will include an extensive tissue culture laboratory for cytological study and research. With the installation of a $250,000 6-megavolt x-ray generator, one of the largest in the world, California Hospital will be the leader in cancer treatment and research in this part of the country.

Pacific Telephone Building

On May 9, 1961 Pacific Telephone dedicated a new communications center at 420 South Grand Avenue. The $31,000,000 8-story center (along with existing buildings on South Grand and Olive) will house the largest concentration of switching apparatus in the world. It is described as being the crossroads of direct dial long distance calls, local and Eastern television programs, microwave radio relay, telephoto, ship-to-shore telephone calls, mobile telephone, teletypewriter, data processing and the new dataphone service. The first-stage improvement amounting to 180,000 square feet of floor space is judged adequate for expansion into 1967, when other floors will be added. An arresting feature of the new building is a 30 x 18 foot mosaic on the building front which pictorially illustrates the scope and breadth of communications in today's shrinking world.

Detention Center

A Los Angeles County Men's Detention Center with facilities for 3,300 inmates and occupying 585,150 square feet of space is under construction at a cost of $13,630,000 on a 17-acre site at Vignes and Bauchet Streets adjacent to the Union Station. Work is on schedule and completion is anticipated by July, 1963. The center will have a 5-floor main building housing administrative offices, service facilities, cell blocks, library, chapel and detention facilities on four floors. Well planned cell block arrangements eliminated the long outmoded two-man cell. To meet the many forms of prison segregation—older prisoners from younger prisoners, first offenders from "repeaters", narcotic addicts from traffic violators—the architects devised several types of inmate housing, varying from dormitories to single cells, according to specific needs.

Water and Power Building

Under contract now is a new general office building for the Los Angeles Department of Water and Power on a 16-acre site in the Civic Center Mall, bounded by Hope, First, Temple and Figueroa Streets. The 17-story structure will have 880,000 gross square feet of space and will cost $26,700,000 to construct. An additional $3,450,000 investment is represented in a 2,400 parking structure and $880,000 in clearing, excavating and landscaping costs. The facility is designed to accommodate 3,200 employees now located in other offices with provision for an estimated ultimate 4,300 employees by 1990. The Department stated that it had in the last ten years invested $619,000,000 in new construction to supply water and electrical service to its customers. Excavation on the new building is in progress and a contract has been entered into with the Division of Highways for the disposal of 480,000 cubic yards of excess excavation on the right of way of the Santa Monica Freeway between Vermont and LaSalle Avenues. This represents a haul of just under 5 miles for the contractor and this phase of the operation—which will save the State of California an estimated $600,000—is scheduled for completion in January, 1962. The Department of Water and Power building will be completed early in 1964.

Dodger Stadium

Los Angeles' own baseball team, the transplanted National League Dodgers of Brooklyn fame, is investing $16,000,000 in a new stadium in the Chavez Ravine area, northern gateway to the Los Angeles Civic Center and the Central Business District adjoining the Pasadena Freeway. The 56,000-capacity stadium, which will also be used by the American League Los Angeles Angels, is designed to be expanded to 65,000 and 85,000 capacity when conditions warrant expansion. Parking for automobiles will be provided in 16,000 individual slots, with ultimate provision for 25,000 parkers. Construction is under way and completion is anticipated in 1962 for the National League opener. The Division of Highways and the City of Los Angeles are expediting plans for early improvements on the Pasadena Freeway which will be a main corridor for attending fans in time for the forthcoming season. Plans call for ramp and street revisions to accommodate traffic and improve access facilities to and from the ball park grounds.

Federal Building

A $27,000,000 appropriation by Congress recently assures construction in the near future of a new Federal Building on a 7-acre site on the east side of Los Angeles Street between Temple Street and the Hollywood-Santa Ana Freeway. This will centralize U.S. Government offices and functions in the Civic Center.

Security-First Notional Bank

Ground-breaking ceremonies have already been held on an addition to the Farmers and Merchants Branch of the Security-First National Bank at 401 South Main Street. Going up 6 stories and providing 90,000 square feet of office space and an extended parking area, the structure will cost $1,500,000 and will be completed in July, 1962.

Little Tokyo

Japanese Americans of Southern California, 77,000 strong, with their neighbors and tourists may in the future look at new developments in the Little Tokyo section of downtown Los Angeles, within an area bounded by Jackson Street to the north, Central Avenue to the east, Third Street to the south and Los Angeles Street to the west. New zoning granted to this community will permit renovation and expansion, which the Japa-



Artist's conception of the new Music Center at the Civic Center. (Photo by Welton Becket and Associates.)



Sketch of the future Los Angeles County Men's Detention Center adjacent to the Union Station. (Photo courtesy of Robert M. Garrick.)



The old Bunker Hill section of Los Angeles which will be replaced by the redevelopment (photo next page). Note the tower of the City Hall visible in the right background.

nese Chamber of Commerce and local businessmen are promoting. Investments estimated at approximately $6,000,000 by private enterprise would assure restoration and new construction to provide hotels, motels, and a shop-lined pedestrian way, much like Olvera Street in the Mexican quarter. A civic improvement association and a large corporation would also be formed to spearhead the conversion of the site into a business, residential and tourist attraction.

Bunker Hill

One of the most ambitious developments anywhere in California or the U.S. is the Bunker Hill Urban Renewal Project being planned by The Community Redevelopment Agency of the City of Los Angeles, having been approved by the City Council on March 31, 1959. The great restoration here will cover an area of 136 acres, framed by First Street, Hill Street, Fifth Street and the Harbor Freeway, representing a gross project cost of $65,099,881 when completed. The blighted area will be cleared and converted to the following land uses: Residential, 27.2 acres; Commercial, 40.4 acres; Parking-Commercial, 24.1 acres; and Public, 3.6 acres.

As the planners put it themselves: "Bunker Hill has languished as a blighted area for half a century—deteriorating steadily and blocking growth of the central city. The present pattern of substandard rooming houses and cheap hotels with the inevitable earmarks of crime, disease, fire danger and excessive public costs which characterize such conditions will soon give way to the most modern and attractive core area development in any American city! It is difficult to calculate the total effect this single undertaking will have on the community when it is completed. It will not only compliment the adjacent Civic Center and the whole central business district, in realizing their full potential as an up-to-date Central City, but will also be of great benefit to the entire city by the 1,000% increase in yearly tax revenue that will accrue to the City Treasury. With the consolidation of this rebuilt area, coupled with the network of freeways, the eventual new public transit system and other new developments, in the planning stage, Los Angeles will no longer be 'in search of a city.'"

Restored Bunker Hill will have tower apartments, at a walk-to-work location, for a residential population of 6,000 to 8,000 persons; commercial uses with an emphasis on office buildings for a working population of up to 50,000 persons, and hotels and motor hotels, for the transient residential population; and parking structures to serve the immediate area and the adjacent Central Business District as well as the Civic Center for as many as 20,000 spaces.

The Community Redevelopment Agency commenced its land acquisition program in April of this year. Although it is expected to require about two years to acquire all the land in the Bunker Hill project area, the Agency expects to initiate the first steps in its land disposition program (sales of property to private developers) before the end of this year. Private developers are expected to invest some $250,000,000 in the rebuilding of Bunker Hill, resulting in the addition of $4,000,000 in property tax revenue annually (present yield $400,000). It is reasonable to expect that before the end of 1961 actual construction will

commence on certain sites and the new Bunker Hill will break the skyline in downtown Los Angeles.

Civic Center Development

The Los Angeles Civic Center is generally a square formed by Sunset Boulevard, Figueroa, First and Alameda Streets and contains 228 acres. Within this area are most of the important governmental establishments and their headquarters staffs which have been associated with the downtown. The Center presently has 13 existing major buildings having a gross square footage of space of 6,700,000, accumulated during fifty-one years of construction and representing an aggregate expenditure of approximately $100,000,000. This complex will number at least 19 structures ultimately. Currently one new building is under construction and engineering plans for three others are being completed. Taken together they will represent an addition of 3,500,000 gross square feet of floor space to the existing total in the Civic Center when completed in the next three years.

Music Center

A music center complex of three buildings is planned on a 7-acre site bounded by First, Hope, Temple and Grand Streets in the Los Angeles Civic Center. It is dedicated as a "Living Memorial to Peace" through the joint efforts of the Music Center Building Fund Committee and the County of Los Angeles. The Music Center, estimated to cost $23,000,000, will provide facilities for the performing arts consisting of a 3,200-seat auditorium, the Memorial Pavilion, on the south side of a landscaped central mall; a circular theatre containing 650 seats, the Forum, and an auditorium with 1,700 seats.

The Forum, a circular building 132 feet in diameter set in a sunken garden, will have a round stage that can be raised or lowered, amphitheatre-style seating and a large semicircular lobby reached from the mall by footbridges. The Center Theatre, immediately to the north and joined to the Forum by a graceful colonnade of white marble columns which surrounds both structures, will have its stage and auditorium housed in an 80-foot high envelope of sculptured concrete with the lobby enclosed on three sides by glass.

The Music Fund Committee has full responsibility for raising the estimated $5,000,000 cost of constructing two of the buildings and has also pledged itself to raising $6,000,000 toward the Music Center project. Los Angeles County has agreed to guarantee $9,000,000 toward the construction cost of the Memorial Pavilion as well as providing the site for the Center.

A major feature of the new development will be a 1,000-car, four-level garage under the two new structures which will be connected to the 1,000-car subterranean garage already planned beneath the Memorial Pavilion. This combined underground parking area will make available 2,000 parking spaces to Civic Center employees and visitors during the day. The County will assume the cost of constructing the garage portion of the project as a part of the overall plan to meet the parking needs in the Civic Center.

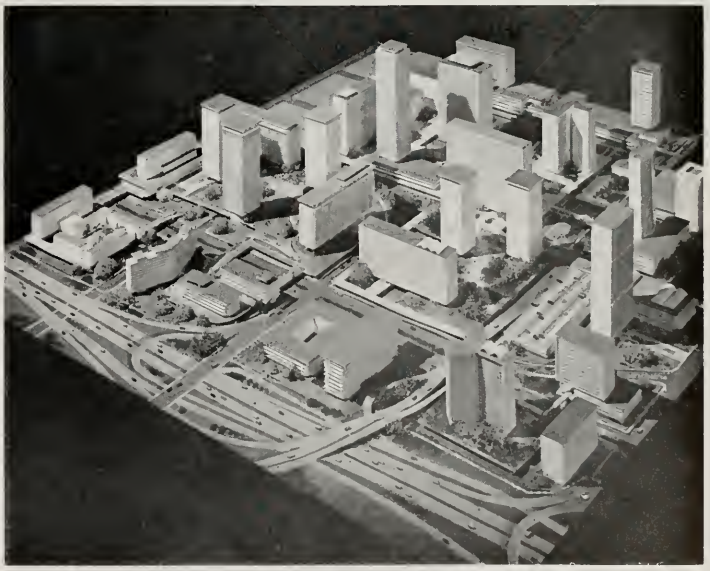
Ground-breaking for the Music Center is planned shortly with the Memorial Pavilion scheduled to open in December of 1962. Construction of the Forum and Center Theatre is expected to be completed in 1963.

Historic Restoration

In the area between the Civic Center and the Union Station, where the city was founded September 4, 1781, its colorful past is coming to life again as buildings in the Old Plaza are being restored. The State, county, city and a private non-profit corporation are working together under a master plan to acquire and rebuild historic buildings and other landmarks. The project is Pueblo de Los Angeles State Historical Monument, a part of the State park system, administered by the City Recreation and Park Department.

The Olvera Street section, long a favorite place for tourists to watch native Mexican craftsmen work, to buy their wares and sample their traditional foods, already has been partially restored. It is operated commercially by El Pueblo de Los Angeles, Inc. The manager is venerable and dynamic Christine Sterling, who conceived the idea of the restoration in 1926.

The main historical buildings in and around Olvera Street, including the



Suggested model for the proposed Bunker Hill Redevelopment Project prepared by the staff of the Community Redevelopment Agency of the City of Los Angeles. (See photo preceding page.) (Photo by Able Photo Service.)

Santa [illegible] Library

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The Police Facilities Building at 150 North Los Angeles Street, typical of new construction in recent years in Civic Center.



ABOVE—The Los Angeles County Hall of Administration in Civic Center. BELOW—Looking east on Wilshire Boulevard toward the new Tishman Building. To the right is the Statler Hilton Hotel.





City Re

Downtown Los Angeles is an area in me
business and industry and a trend inward b
accessibility, the movement involves new cor



Westerly view of the Signal Oil Building on Wilshire Boulevard above the busy Harbor Freeway.



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sis, characterized by a trend outward of uarters agencies. Based largely on freeway renovation, restoration and slum clearance.



ew functional design is embodied in the Southern ounties Gas Company Building at 8th and Flower Streets.



The Los Angeles County Hall of Records under construction in Civic Center.



ABOVE—The Los Angeles County Courthouse, one of the many "headquarters" type of improvements in Civic Center. BELOW—Looking down upon the angular beauty of the new California Bank Building at 6th and Spring Streets.





Model of the new wing of the California Hospital proposed for construction in 1962. (Photo by Herbert Bruce Cross.)

Avila Adobe, Sepulveda House and Pelanconi House, will be repaired and restored.

The former Methodist Headquarters Building, on the northwest corner of Los Angeles Street and Sunset Boulevard, will be converted into a Latin American Trade Mart. It is contemplated that the consulates and trade offices maintained in Los Angeles by the republics of South and Central America will be housed here in an informal, colorful south-of-the-border atmosphere.

The Simpson Building, at North Main Street and Sunset Boulevard, has been rebuilt, and one part is occupied by a branch of Bank of America. All the furnishings, draperies, brickwork, tile and woodwork were imported from Mexico and combined to create an interior of great beauty and charm.

Across the Plaza in the blocks bounded by North Main, Los Angeles and Plaza Streets, and Arcadia Street (which separates the section from the Santa Ana Freeway), the work of restoration is under way. Already completed is the old Fire House, as it functioned in the 70's, complete with an old city-owned fire engine which has been rebuilt and polished brighter than new.

Principal buildings being restored or planned for work later are the Pico House, the city's first three-story building, erected in 1869, which will again serve as a hotel; The Merced Theatre, first in Los Angeles; Masonic Building, where Los Angeles' first Masonic Lodge met; and a few newer and less historic structures. It is contemplated that operation of the Pico House, its dining room and a number of small ground-floor shops beneath the Merced Theatre will be leased to a concessionaire later.

The original financing for the project in 1953 consisted of $750,000 appropriated by the State Legislature and an equal amount provided by the city and county. Ultimately a great deal more will be spent, including private funds.

California Mart

A $50 million California Mart development is being planned to occupy an entire city block (four acres) bounded by Ninth, Main and Los Angeles Streets and Olympic Boulevard in downtown Los Angeles.

Construction will begin early in 1962. The development consists of A Tower (first unit) 13 stories with 400,000 square feet of display space; branch bank building; auditorium exhibition hall; B Tower, 20-story display offices building; Mart hotels will be a 16-story high-rise structure and a two-story motel built around a swimming pool patio plaza; other features include a three-level subterranean garage, restaurants, night clubs, specialty shops, etc. Development is planned as an international marketing center for all consumer goods and related fashion lines. Charles Shattuck,



The general offices of the Los Angeles Department of Water and Power as they will look when completed.

recognized dean of Southern California realty appraisers, says of the Mart: "Feasibility of the project is increased by its favorable geographical relationship to existing transportation arteries, particularly the central freeway interchanges, the central business district, the retail area and the financial center."

Traffic

Cordon counts of traffic by the City of Los Angeles Traffic Department within an area somewhat larger than the Central Business District, bounded by the Harbor Freeway, Hollywood Freeway, Los Angeles Street and Pico Boulevard, showed appreciable increases over 1957 in passenger vehicles entering and decreases in persons entering.

A count conducted in May, 1960, during the 16-hour period between 6:00 A.M. and 10:00 P.M., showed 679,000 persons entering, a decrease of 9,000 persons from the 1957 count year. However, the "maximum daytime peak accumulation" showed an increase of 25,000 persons over the accumulation tallied in 1957 in the Central Business District: in 1960 the total was 157,000, in 1957 it was 132,600. Passenger vehicles entering the count area numbered 296,300, a 5,400 increase over the 290,900 in 1957. The high hourly accumulation of passenger vehicles during the count period in 1957 was 36,500, whereas in 1960 it was 51,900.

Vehicular entry into and exit from the Central Business District has been improved by recent freeway construction; it has been improved by projects aimed at easing the traffic flow in the ring of freeways formed by the Hollywood, Santa Ana, Golden State, Santa Monica (under construction) and Harbor; the inner circulation has been relieved through a system of one-way city streets and new pedestrian controls at key intersections. Removal of through traffic from city streets promotes local business patronage and reduces the parking problem.

Metropoliton Transit Autharity

The Metropolitan Transit Authority, a self-supporting public corporation of the State of California, has since March, 1958 been operating a major bus and streetcar system in Los Angeles County, serving also areas within Orange, Riverside and San Bernardino Counties. Its 91 lines carry more than 750,000 passengers a day, using 1,591 buses, 89 trolley coaches and 164 streetcars.



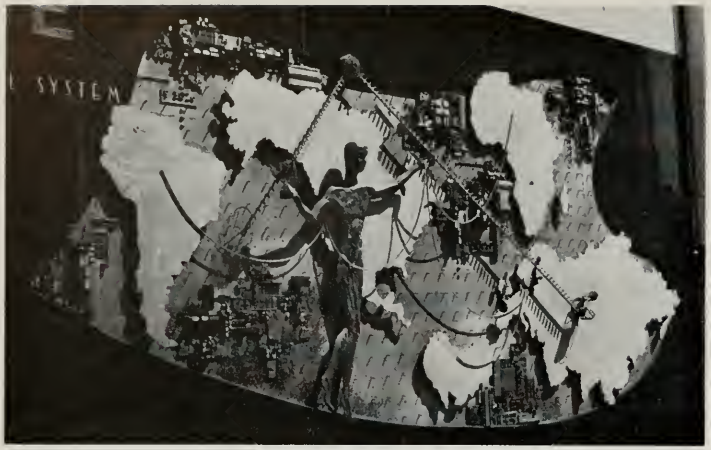
The proposed new addition to the Farmers and Merchants Branch of the Security First National Bank. (Photo by Albert C. Martin and Associates.)

Action by the California Legislature in 1961 allows implementation of a mass rapid transit system by the Metropolitan Transit Authority, studies for which have lately been completed, for an initial route to begin at Century City in West Los Angeles and terminate in the City of El Monte, a distance of 22.7 miles. A 12-mile segment of the route from Century City to Union Station in downtown Los Angeles would be in subway, with the balance above ground. The project, estimated to cost $192,000,000, would require three to four years to complete.

The MTA system as it operates today, serving the Central Business District and extended areas, is a prime mover of large masses of population. This movement, when interrupted as it was in 1960 by a strike, can have a deleterious effect upon other vehicular traffic plying between points in the entire Metropolitan area complex and the Central Business District. As of June 30, 1961 Los Angeles County had 3,145,949 motor vehicle registrations.

Freeway Network

The downtown, the Central Business District, the Civic Center and the Central City Area, are served by a network of freeways, the Hollywood-



The 30 by 18 foot mosaic in front of the Pacific Telephone and Telegraph Building on South Grand Avenue. Tile, rock and pieces of actual telephone equipment are used to explain the role of communications in today's shrinking world. (Photo by Ted Schmidt.)

Santa Ana on the north, the Santa Ana-Golden State on the east, the Santa Monica on the south and the Harbor Freeway on the west. All of the downtown portions are completed with the exception of the Santa Monica Freeway linking the Santa Ana Freeway with the Harbor Freeway and points west. The Santa Monica freeway is under construction in viaduct—approximately 20 feet above existing surface streets—from the Santa Ana Freeway to Hoover Street west of the Harbor Freeway, a net distance of approximately 4 miles. Total cost of this section which will be completed by the summer of 1962, will be approximately $31,000,000.

The eight-lane viaduct structure crosses 38 city streets. Ten streets will be deadended and 4 relocated, although during construction all streets will remain open to traffic. There will be enough space for areas totaling 80 acres beneath the viaduct which will be available to lease for public parking and other approved uses, converting what would otherwise be lost area into a useful, revenue-producing facility.

Recent construction in the vicinity of downtown includes two contracts on the Golden State Freeway, between 6th Street and Pasadena Avenue, 2.4 miles, completed in March, 1960, at a construction cost of $7,778,000 (plus realignment of a section of the San Bernardino Freeway and the interchange, $800,000); the Long Beach Freeway Extension connecting the Santa Ana Freeway with the San Bernardino Freeway, 3.7 miles, completed in April, 1961 at a construction cost of $6,650,000; and the East Los Angeles Interchange between the Golden State, Pomona, Santa Ana and Santa Monica Freeways, 2 miles, completed in June, 1961, at a construction cost of $10,326,600.

The East Los Angeles Interchange, located on the east side of the Central Business District is the critical key in the downtown Los Angeles Freeway Loop. The complex is composed of one "Y" and two "X"-type junctions with numerous access ramps to the local city street system.

The Santa Ana Freeway, built in 1947, angles northwesterly through the area and by 1975 will be carrying an estimated 135,000 vehicles per day. In 1956 at the junction of the San Bernardino Freeway, the Santa Ana Freeway carried 106,000 vehicles; today, in 1960, it carries 103,000, which is the only instance of decrease in vehicular movement in the downtown area and reflects diffusion to newly constructed bypass routes (Golden State, Long Beach Freeway).

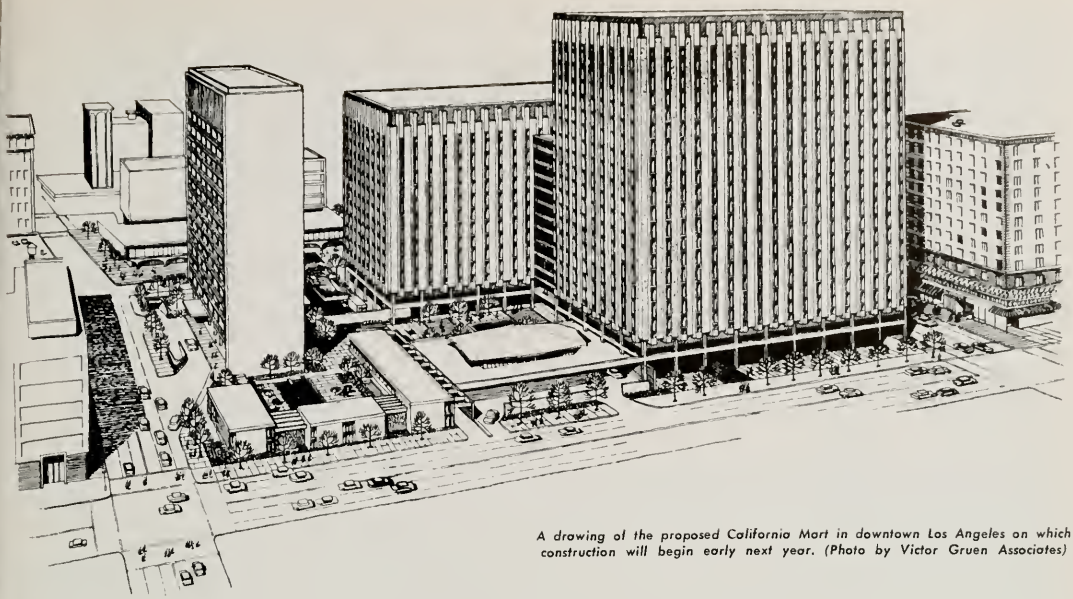
The Santa Monica Freeway, currently under construction, is expected to be carrying 180,000 vehicles per day by 1975. The estimated average daily traffic for this freeway as far west as the Harbor Freeway after construction in 1962 is 70,000. The frontage road system on the Santa Monica Freeway will dissipate 50% or more of the traffic destined for midtown at Santa Fe Avenue, Alameda Street, Central Avenue and Los Angeles Street connections.

The Golden State Freeway joins the interchange from the north as a portion of the freeway loop around the Central Business District. This freeway will carry an estimated 163,000 vehicles per day in 1980. The portion open to traffic now in the vicinity of downtown carries 30,000 vehicles.

The Pomona Freeway, State Route 172, will be the easterly leg of the complex upon construction and will carry 163,000 vehicles in 1975. Before 1980 the interchange complex is expected to be handling 450,000 vehicles per day, or nearly 600,000 individuals. In comparison, the 4-level structure at the junction of the Harbor-Pasadena Freeways, and the Hollywood-Santa Ana Freeways presently carries 355,000 vehicles per day.

Construction in progress on the Santa Monica and Golden State Freeways will when completed render relief to the "slot" area from the 4-level structure to junction of the Santa Ana-San Bernardino Freeways – in terms of percentages, this relief will amount to a 16 to 19% reduction in traffic from the 185,000 vehicles using this facility now to 150,000 anticipated for the future. On the other hand, changes in travel patterns occasioned by diversion of traffic from the "slot" indicate a slight increase of traffic on the Harbor Freeway or a 20,000 per day gain over the present 210,000. This forecast is based upon mid-town destinations with the bulk of the exits being via 9th and 6th Streets.

Thus another component is added to the growing network of freeways in Metropolitan Los Angeles that will



A drawing of the proposed California Mart in downtown Los Angeles on which construction will begin early next year. (Photo by Victor Gruen Associates)

begin to function as a system, providing alternate routes to accommodate the areawide traffic flow patterns. To the individual, system operation will mean greater speed, safety, convenience and comfort in the movement of himself and his goods between points of his choice at a time suitable to him. The completion of this important distribution complex will implement the switching of traffic between freeways and the diffusion of traffic into local streets.

The Division of Highways is meeting the challenge of expanding, changing Los Angeles with a planned network of superhighways for the transportation of people and goods. As of April 25, 1961, the State Division of Highways had expended for rights of way and construction or obligated $730,599,000 on freeways and expressways in Los Angeles County, representing 210 miles.

To properly gauge Los Angeles County's rapid advances in freeway development, it should be pointed out that on April 5, 1951, just 10 years ago, the total expressway-freeway mileage was 63.2 and construction expenditure $41,631,000.

Conclusion

A fitting general conclusion to this discussion of Los Angeles in Renaissance and the meaning of the multiform changes, growth and expansion that are attending it, is contained in *Metro*, a publication of the American Automobile Association.

Far from being a deleterious influence, as critics of the car allege, this development of the suburbs along the pleasanter lines made possible by higher incomes, the auto, and highways, is having a rejuvenating effect on central cities. It is causing them to study the possibility of rebuilding their slums and other congested areas. Without this pressure from the suburbs, the central cities might have continued to be areas of congestion and often of ugliness.

It is now becoming possible to redesign and rebuild downtown areas because the competition of suburban development provides the incentive, and to some extent because the migration to the suburbs provides vacancies, and sets downtown values closer to levels which make redevelopment and renewal possible. The successful use of the auto in the suburbs is therefore spurring a revitalization of downtown. To insure the continuance of urban renewal, expenditures on urban and suburban highways must be increased.

The expansion of urban highway systems, and their growing use has begun to save our larger centers of population from decay. If the central cities are to survive, they must replace some of the business they have lost. The new highway networks are helping to make this possible. They are making it possible for residents of the far-flung suburbs to reach the central city more conveniently for the services it can provide best instead of having to duplicate these services in the peripheries. Instead of facilitating the development of new relatively self-sufficient cities, the highways are tying the suburbs to downtown.

There is every reason to believe that central business districts will continue to undergo change in their character. But examples of some cities have made it clear that through planning, renewal and provision of adequate transportation, our cities can reach new heights of vigorous growth and the provision of pleasant living and working conditions.

Legal Decisions

State Supreme Court Rules On Three Property Valuation Cases

By CHARLES E. SPENCER, JR., Attorney, Division of Contracts and Rights of Way

During the past year, the Supreme Court of California handed down three important decisions relating to the valuation of real property in eminent domain proceedings. These three cases—*People* v. *Ayon*, 54 Cal. (2d) 217; *People* v. *Symons*, 54 Cal. (2d) 855; *People* v. *Murata*, 55 Cal. (2d) 1, were handled by the Los Angeles Office of the Division of Contracts and Rights of Way. The *Ayon* case was decided in May of 1960. The *Symons* case was handed down in December, followed a few days later by the *Murata* decision.

In each instance the Court was required to carefully review all the facts to be assured that the property owners were not being denied their constitutional right of just compensation and at the same time not to transfer an unreasonable burden to the State and taxpayers. The results are equitable decisions which will be of great assistance in the freeway program by eliminating the threat of some of the unreasonable claims for damage for right of way acquisition and yet clearly assuring the property owner payment of the fair market value for his property, and damages for certain losses resulting from freeway construction. In all three cases, the Su-



Looking south at the Yor-Way Market from the center of Azusa Avenue after reconstruction of the highway. (See next photo.)



A southward view of the Yor-Way Market before Azusa Avenue was reconstructed. Photo by Verne Cox. (See previous photo.)

preme Court affirmed the position of the Department. The cases will be discussed in the order in which they were decided.

The Ayon Case

The *Ayon* case presented two basic questions:

(1) Where an owner conducts a business on his property, is he entitled to recover for loss of business which results when part of the property is taken for freeway purposes?

(2) When freeway construction necessitates a temporary interference with access to the property, does the owner have a right to collect damages for this interference?

The property in question was used as a supermarket with an adjoining parking lot. The property fronted on Azusa Avenue and First Street in Azusa, California. Before the improvement by the State which gave rise to this action, traffic traveling both north and south on Azusa Avenue had access to the market parking lot.

The improvement involved widening Azusa Avenue, separating north and south-bound traffic by a divider strip, and turning Azusa Avenue into a one-way street for north-bound traffic a short distance north of the market property. At the same point, traffic would be two-way in a southerly direction with access to the parking lot from Azusa Avenue limited to south-bound traffic by reason of placing the divider strip between the north and south-bound lanes. As a part of the redesigning of Azusa Avenue, the State acquired a 10-foot wide strip of land from the defendants along the entire eastern boundary of the property.

Defendants Agree

The defendants agreed to the Department's appraisal for the value of the part to be acquired from them and for all damages arising from the widening of the street and for the severance damage to the remainder of their property. They did, however, by stipulation, reserve the right to claim additional damages, if any, arising from loss of business, customers and good will because of an alleged impairment of access. The Supreme Court of the State of California ruled that these items—loss of business, customers and good will, were not compensable as such.

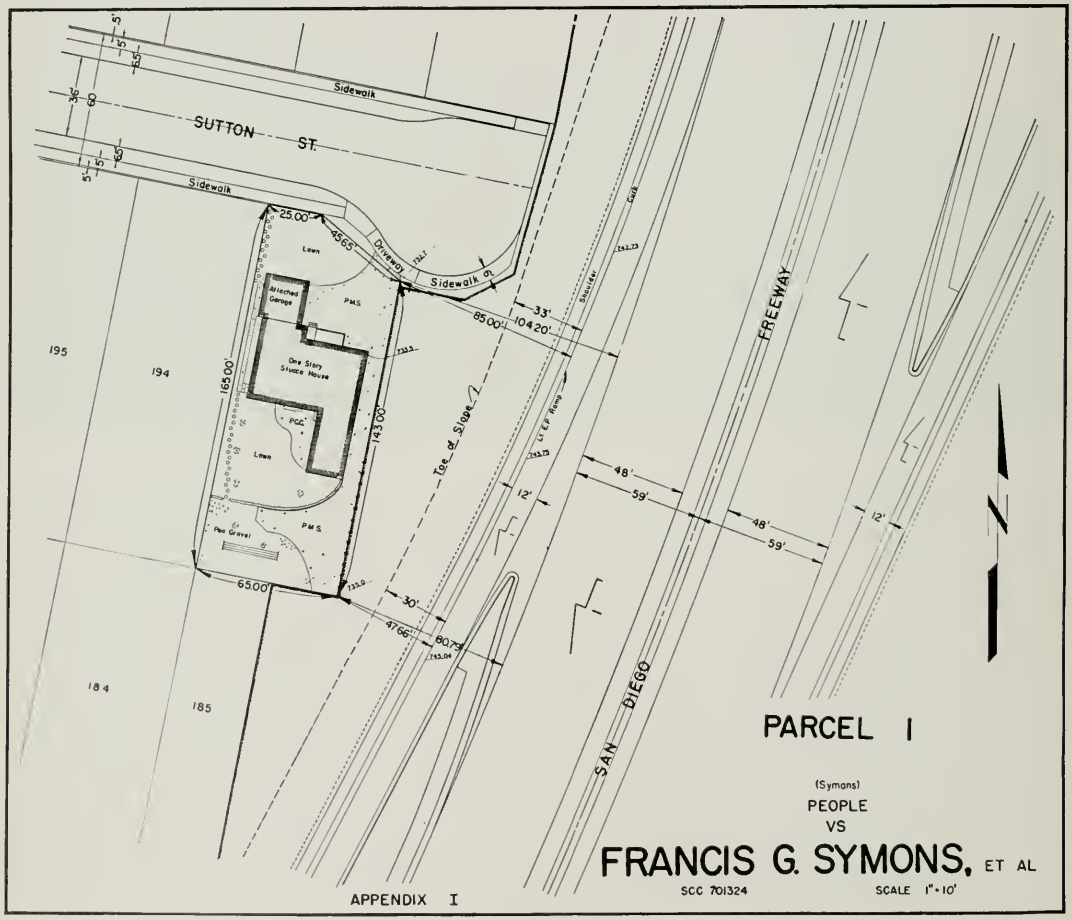
The Court noted that modern transportation requirements necessitate the continual improvement of streets and relocation of traffic and that a property owner has no constitutional right to compensation simply because the streets upon which his property abuts are improved so as to facilitate the traffic flow on such streets.

The Court reached the obvious conclusion that the true test was not whether or not there had been a loss of business but whether there had been an actual diminution in the market value of the property. The Court further found that the access to the property from Azusa Avenue had not been substantially impaired by the construction.

The other question raised was whether or not an owner can collect damages for temporary interference for access to the property during construction. The engineer for the State testified that the entire improvement would be completed within 90 days and that during this period access would at all times be maintained to the parking lot from Azusa Avenue. Although the improvement had not yet been constructed, the defendants attempted to prove that construction would take at least six months instead of 90 days, and that the attempt to maintain access would not succeed.

Ingress, Egress Necessary

The Court observed that it is often necessary to break up pavement, narrow streets and provide other temporary modes of ingress and egress to abutting property during the period streets and highways are being improved, and that reasonable and temporary interference with the property owner's right of access is therefore not compensable. In further defining the rights that a property owner has, the



A map showing the location of the Symons property in relation to the San Diego Freeway and Sutton Street.

Court pointed out that whether or not there will be any further and improper interference with defendant's right at that time is uncertain and highly conjectural. If the improvement is not carried out as proposed, and if, as a result, unnecessary or unreasonable interference with defendant's rights of possession and rights of access occur, then they have a right to bring an action for such damages.

The Court, in restating the rights of property owners, considered the burden on the public by emphasizing that it would unduly hinder and delay, or even prevent the construction of public improvements, to hold compensable every minor item of inconvenience or interference.

The second of the trio of cases considered is *People* v. *Symons*. In this case the State constructed a freeway on the property adjacent to the Symons' property. The defendant's property was a single family home on a residential lot on the south side of a city street which was *cul de saced* at the freeway boundary. The only property acquired from the Symons was for the purpose of constructing a *cul de sac* on the city street.

The Symons and the State agreed as to the market value of the property actually acquired and, in addition, the State agreed to reconstruct the driveway and to reinstall the lawn and sprinkler system.

Domages Sought

The Court was faced with the basic problem that the defendants were seeking damages for the construction of an improvement, not on their land, but on adjacent property. The defendants sought to introduce evidence of an alleged change from a quiet residential area; loss of privacy; loss of view to the east; noise, fumes and dust from the freeway; loss of access over the area now occupied by the freeway, and a misorientation of the house on its lot after the freeway construction.

The California Supreme Court held that the only items of damage which could arise would be those resulting from the *cul de sac* itself, and not from the freeway. The rationale of the Court was that the *cul de sac* had no direct relationship to the freeway inasmuch as any damages arising from the construction of the freeway would have occurred whether or not the *cul de sac* was constructed.

The Court pointed out that it has long been recognized that there is no right to recover for all elements of damage caused by the construction of a public improvement. There are many things which might make a property less desirable but this is not necessarily an injury to the property itself, as much as an influence affecting its use for certain purposes.

Adjacent Improvements

There are many instances where improvements are constructed on lands of another and which influence adjacent property, but this does not entitle an owner of the affected land to damages. For example if a private citizen were to acquire property next door and were to construct, let us say, a factory with a change of zoning to such use, there could be no claim for damages arising therefrom. The Court concluded, since it is not proper to allow damages against a private citizen under these circumstances, it certainly would not be fair to enlarge the State's scope of liability under similar circumstances, which is exactly what the defendants were attempting to do.

The Court pointed out its responsibility in these instances by stating that it has assumed the burden of defining the rights of property owners because of the necessity to safeguard constitutional rights and to see that the cost of public improvements are not unduly enhanced. Thus, if the Court had defined the rights of the property owner other than it did in this case, it would have, as it stated, "imposed a severe burden on the public treasury and in effect placed 'an embargo upon the creation of new and desirable roads' ".

The third case previously referred to is *People* v. *Murata*. This case involved the question of what date of valuation was to be used on the retrial of a freeway condemnation case.

Property Valuation

A California statute provides that the property is valued at the date of issuance of summons unless the trial is not held within a year of such time, and then the date of valuation shifts to the date of trial unless the delay is caused by the property owners. For all intents and purposes, the first trial was held within a year after the issuance of summons, but because of certain errors caused by the defendants in the first trial, a retrial was granted. The second trial was held more than a year after the original issuance of summons. The Court, in summing up the proper interpretation of the statute, determined that the valuation date should remain the same as that of the original trial. The Legislature in enacting the code section involved could have easily provided for a change of valuation date upon successive trials or retrials. It was obvious, the Court said, that the Legislature had in mind only the first trial of the action and to hold otherwise would mean that the Legislature had deliberately deprived the State of an effective appeal. Likewise, any other interpretation would also deprive the property owner of an effective appeal if his property was involved in an adverse market.

Again, the Supreme Court of the State of California was faced with a situation where due consideration had to be given to a judicial determination which would clearly provide just compensation to the property owner and yet not unjustly penalize the public.

Interstate Highway Progress Reported

A compilation released in August by the Bureau of Public Roads showed that California is making good progress on the Interstate highways within its borders. The report, giving figures as of June 30, showed that of the 2,177.4 miles of Interstate highways in California, 183.6 miles are completed to full or acceptable standards, and that another 223.6 miles are improved to standards adequate for present traffic.

A total of 596.8 miles were open to traffic, 159.7 miles under construction and 1,067 miles in the engineering or right of way phases.

Painting the Bridge—2

Gantries Aid Bridge Repair

By D. EWING MARSH, Maintenance Superintendent, San Francisco-Oakland Bay Bridge



ALTHOUGH the San Francisco-Oakland Bay Bridge is mostly built of heavy steel, there are locations such as the sidewalks and the overhead structure in the cantilever and 504-foot through truss spans where the steel is comparatively light and the steel temperature changes more rapidly than in other locations. This rapid temperature change causes a breakdown of the paint film on seams. In this portion of the bridge, we begin repainting at intervals of 3½ to 4 years. It is necessary to keep these seams well sealed because of their awkward position on the bridge directly above upper-deck traffic, and the fact that it would be extremely difficult to repair them if rust became extensive or heavy between the parts of built-up members.

The sidewalk and chord soffits on the bridge are what we call condensation surfaces. Walks are very light compared to other bridge steel, being only ⅜-inch plate, and flat on the bottom so that dew or condensation forms and hangs there. This cannot run off but remains in droplets absorbing contaminants from motor vehicle exhaust. Paint on these surfaces has a very short life. Sidewalks are non-stress carrying members and do not give too much concern. Various methods have



Inspection bridges such as the one in the photo were used originally as crossovers between catwalks during the cable spinning. Later 14-by-62-foot platforms were added so that they could be used in painting the floor system.

been tried on these walks to make the paint last longer, but the condition is so severe compared to other conditions on the bridge that nothing has proven completely effective in lengthening the life of the paint film to equal that on other portions of the bridge.

Effect of Rain

Surfaces on the bridge steel which receive rain and are washed clean have a minimum of rust, except as noted under "temperature change". Prevailing winds normally come from the northwest side of the bridge, but not in the rainy season. The heaviest rains come from the southwest, are not accompanied by high winds and consequently do little *good* beneath the decks. High velocity windstorms from the southeast accompanied by rain blow a large amount of water through the trusses on the south side of the bridge, and the effect of this water is very noticeable. The ends of floor beams, exposed to this rain water blowing in, will have little or no rust, while the opposite end of the same beams, subject to motor vehicle exhaust and generally unwashed, may have the entire surface rusted and require 100-percent sandblasting.

Paints in Use

Between 1940 and 1945, the formula for the aluminum vehicle was changed from a long tung oil varnish to a phenol formaldehyde type. The present varnish is known as California State Specification 58-I-04, and is a 100 percent phenol formaldehyde type. The resin used is CKR2432, or equal, corresponding to Federal Specification MIL-R-15189A. Aluminum paste used is Specification TT-A-468, Type II, Class B leafing type, except that nonvolatile is 74 percent minimum. Two pounds of this paste are used per gallon of aluminum vehicle.

Several years ago, we began using a semi-quick drying red lead paint which weighs 21.7 pounds per gallon. This paint dries satisfactorily for recoating in 16 hours. We have not abandoned the use of slow drying paint, but use these quicker drying paints in locations where we can get at the surfaces for repainting more rapidly, thereby reducing contamination between coats during the repainting operation. Semi-quick drying paint



The Magic Carpets, 6 feet wide by 85 feet long, are suspended from the upper chord. For many years they have provided a platform for repainting the lower deck floor system. They are now being replaced with power-operated travelers (see photo next page).



The gantries or upper deck travelers run on a three-rail overhead track with air-powered drive. The working platform is 17 feet wide and 59 feet long.



Lower deck travelers used on the East Bay section provide a 19-by-73-foot platform for painting the lower deck floor system. They are hung from air motor-driven trolleys. Folding ends allow clearance when passing through the bridge piers. These are replacing the older Magic Carpets (see photo previous page).

is compatible with our linseed oil paints, and they are frequently mixed together in equal portions for color differences between coats, or some of this quick drying is added to the regular paints to speed the drying.

Another item of interest which is frequently used to our advantage is leafed metallic lead paste. This is added to the lead coats to reduce or speed the drying time and provide a better tooth or bond between coats. We add approximately 1½ pounds per gallon in our mixing tubs. It is not practical for us to buy paint with this mixed in at the factory. Our use is not continuous, but varies with the locations where we are working as well as with the weather conditions.

State Specification items used at San Francisco-Oakland Bay Bridge during 1960:

1. First coat paint
 a. Red lead linseed oil—27.8 lbs./gal. Specification 58-G-60
 b. Semi-quick drying red lead—21.7 lbs./gal. Specification 58-G-53
 c. Phosphoric acid wash (Mil-C-15328A) Specification 52-I-05
2. Second coat paint—24.4 lbs./gal. Specification 58-G-61
3. Aluminum finish coat—Specification 54-G-80
4. Steam cleaning compound—medium duty (Bay Bridge formula) Specification 59-A-77

Over the years, coal tar coatings have been used in some areas. The quantities have been small, but the results in these specific areas have been excellent.

The following quantities of our regular paints were used during the fiscal year ending June 30, 1960.

First coats	
Red lead linseed oil	1,472 gallons
Semi-quick drying red lead	4,945 gallons
Second coat red lead	2,890 gallons
Finish coat aluminum	5,945 gallons
Total	15,252 gallons

Everything practical is done to shorten the time between coats, thereby reducing contamination between coats. This is particularly important between the first and second coat. One coat of red lead paint has a very short life in our exposure and it is not satisfactory to leave unrecoated for more than two months and in some locations for only three weeks. At times,

we have had two coats of red lead paint go for nearly a year with very few bad results. This was not done intentionally, but because of accidents where surfaces had to be left until access could be had at a later date.

Surface Preparation

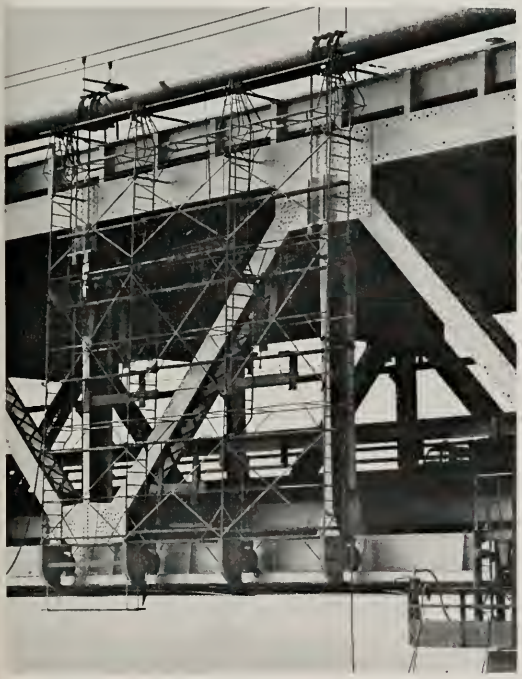
Our present policy is to steam clean all surfaces which can be cleaned without serious inconvenience to traffic. Under this plan, we have steam cleaned to the tops of the suspension bridge towers 275 feet above the upper deck with the steam cleaners on the lower deck of the bridge adjacent to the tower legs. This is followed by sandblasting to remove rust. The steam cleaning reduces the amount of sandblasting by removing dirt and other stains which might be mistaken for rust. Another advantage is the reduction in cost over that of blasting, and we do not wish to remove good paint unnecessarily.

We only do spot sandblasting except in rare instances, and no blasted surfaces are left overnight. They are all painted the same day they are blasted and receive two spot coats of lead paint, one of which is a spot coat on all seams, rivet heads, and edges in addition to the blasted areas. This is followed by a third coat of lead paint over the entire surface, which in turn is followed by the finish coat of aluminum. This brings all blasted surfaces to the same standard of protection which was originally used at the time of construction.

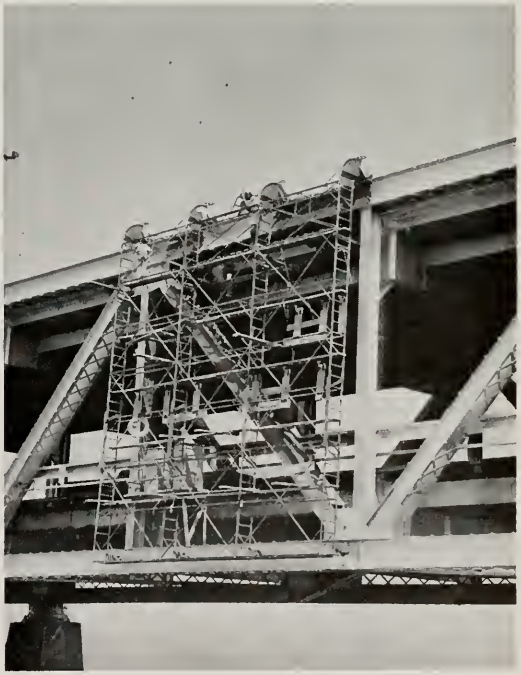
Another routine which we have adopted is that in many places where we are unable to clean out cracks which show indication of rust, we pour into that crack the phosphoric acid diluent of vinyl wash primer. This acid treatment is compatible with any water which may be in the crack, creates an inert surface on the steel it touches, and has a tendency to inhibit any rust which it touches or which absorbs it. After this has had a chance to dry, the open edge of the crack is given a treatment of a surface preparation oil, of which there are several on the market. These do not contain driers and are compatible with paint. Following this, the cracks are filled with caulking compound and sealed over with the usual several coats of paint.

Mechanized Scaffolds

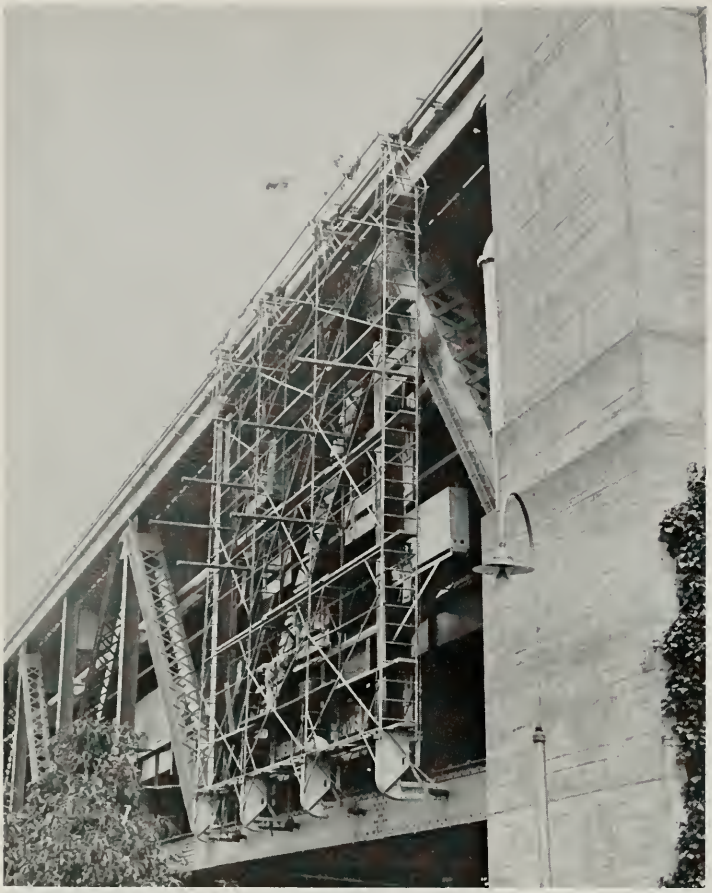
We attempt to have all our scaffolding in as large units as possible and mechanized to reduce human effort in moving the scaffold and thereby wasting time. At present, we have eight scaffolds covering an entire truss panel running on the outside of the bridge trusses for painting the truss web system. The first of these truss web scaffolds was built in our own shop in 1946 and others built to our design



The Bird Cages or truss web scaffolds an the West Bay suspension spans run on the inspection bridge track on the lower chord. These scaffalds are 40 feet high and 36 feet wide and support platforms for painting truss members. They are mounted outside the bridge to keep painters away fram adjacent traffic.



The East Bay Bird Cage ar truss web scaffold, alsa 40 feet high and 36 feet wide, is suspended from a portable truck an the top bridge chard. All Bird Cages have folding platforms providing access to truss diagonals slaping either to right or left.



This West Bay truss web scaffold was temporarily mounted on overhead track for work on the Yerba Buena Island Spans.

later that year. Two covering a half a panel were erected at the curved spans in February, 1961. These enable the men to paint the trusses without being on the narrow sidewalk adjacent to the highway and increase safety by keeping the men as far as possible away from traffic. There are currently five travelers running underneath the upper deck suspended on overhead rails.

These platforms are approximately 15′ x 60′ and cover half of a floor system panel providing easy access and a minimum amount of rigging time moving from panel to panel. In 1948, we built and erected the first of these and a half mile of track with our own crew. A new scaffold was installed in 1960 underneath the lower deck for painting approximately 3,000 feet of bridge on the east end. This platform is also approximately 15′ x 75′. Three more are in the design stage nearly ready for contract.

Run On Tracks

Seven inspection bridges running on track were provided with the bridge originally. These were 4 feet wide by 76 feet long, powered by hand, and were for inspecting the lower-deck floor system on the suspension bridge and the main span of the cantilever. Wider platforms, 14 to 15 feet wide, have been placed on these scaffolds and power drive has been installed.

Special scaffolds to run on the main cable hand ropes were built in 1947. These are adjustable so they may be kept level as the cable changes slope. Special elevator-type platforms are used for painting the suspender ropes. For painting the suspension bridge towers, an articulated scaffold was built in 1939 which completely encircled a tower. When not in use on the big towers, sections were used elsewhere. This was operated by hand-powered jack machines. It is now old and has deteriorated to such an extent that when the towers are painted again, we anticipate designing a new scaffold with power drive. For vertical transportation several different commercial makes of air-powered scaffold machines are used. We have learned that no one commercial machine answers all our problems, but that each type of machine which we have works better in some places than any of the others.

There is currently being installed on the Bay Bridge a 4-inch air line the full length of the bridge for conveying compressed air to working locations. Compressed air driven tools have proven to be the most adaptable to the variety of conditions encountered on this bridge. Originally, electric-driven tools were tried, but because of operating conditions, they were not satisfactory, although they might be on a bridge where power is more accessible and other conditions are different.

Areas Repainted

At the present time, January, 1961, the West Bay suspension bridge towers have been painted twice under maintenance at intervals of 12 years. The same applies to the main cables and suspender ropes. The suspension bridge trusses are now being painted for the second time under maintenance. The upper and lower-deck floor system painting is a continuous process which never ends and is carried on from the center of the suspension bridge toward the ends, or in other words, downhill from the center. This floor system has been painted at an average of eight-year intervals,

although on the first time over portions went as long as 20 years.

On the East Bay as on the West Bay, painting of the floor system is a continuous process. The average time between coats being eight years, with portions on the East Bay having gone as long as 18 years. The trusses on the East Bay 288-foot truss spans are now being repainted for the second time under maintenance. All bents supporting the East Bay portion of the bridge are now being repainted for the third time. The 288-foot Yerba Buena Island spans have just been completed for the second time on the lower-deck floor system and the third time on the upper-deck floor system. The trusses are about to be repainted for the second time under maintenance.

Four-Year Intervals

In the 504-foot through truss spans and the cantilever section, which are roughly 2,500 feet long each, we find it necessary, because rapid temperature change causes paint failure on cracks and seams, to start a paint crew through the overhead structure (struts, bracing connecting the trusses, and the trusses themselves) at intervals not exceeding four years. Luminaire standards throughout the bridge have a very long life, the principal deterioration on them being abrasion caused by the use of the tower or ladder trucks.

Although large quantities of lead and aluminum paint are sprayed, it is a very small percentage of the total paint applied here. We have observed, however, that the speed gained is not always to our advantage, it having been found that paint which is applied to a surface with pressure, that is, by friction, is worked into the surface with a better bond and gives us a longer life and a better coat of paint. This undoubtedly is because any surface contaminants are worked up into the paint film and do not lie undisturbed between the old paint and the newly-applied coat.

The general order of painting is determined by:

1. Policy of preventive maintenance.
2. Anticipated life of paint coatings under local conditions on the structure.
3. Techniques required for specific locations.
4. Accessibility.

Routines vary between the suspension bridge between San Francisco to Yerba Buena Island and the cantilever and truss spans from the island east to Oakland. They are thus listed in the general order of their frequency. Groups are generally determined by the type of scaffold or rigging used.

West Bay Crossing

Parts of the suspension bridge done in units are:

1. Floor systems—upper and lower deck.
2. Truss web members and rocker posts.
3. Tower and bent bases.
4. Towers and bents outside, suspender ropes, main cables.
5. Main cables in saddles and anchorage splays.
6. Roadway faces of walks and skid girders.
7. Bents and towers inside.

Truss web painting also includes inside the upper box chord, suspender rope connections and back of upper walks.

Inside the lower box chords and back of the lower deck walks are done with the lower-deck floor system. At this time, lower chord gusset pockets receive an extra treatment.

Upper-deck floor system includes the upper deck road strut and expansion details at the towers. Because of rapid paint failure on condensation surfaces, the bottom of the upper chord and the attached gusset pockets also receive an extra treatment.

Lower-deck road struts and expansion details on the main towers are painted from the lower tower scaffold.



A special narrow 15-foot wide Bird Cage mounted on overhead tracks is used on the curved spans on the East Bay section.

East Bay Crossing

Policy on this section of the bridge has been to maintain the many large connecting points separately because of the special tools and techniques necessary for working in such very inaccessible places. To keep scaffolding and gear at a minimum when painting the cantilever and 504-foot through truss spans above traffic, laterals, struts, portals, and sway frames are completed as the first operation; truss verticals and diagonals second; and top and batter chords last.

Parts of the East Bay structure done in units are:

1. Above decks or top side.
2. Upper-deck floor system.
3. Lower-deck floor system.
4. Truss web.
5. Bents and towers outside.
6. Large connecting points.
7. Inside of box chords, bents, and towers.
8. Roadway faces of walks and skid girders.

Conclusions

In drawing some very general conclusions based on our experience of painting the Bay Bridge since 1937, we feel that ease of accessibility which includes the use of large power-driven scaffold units is of primary importance. When we have had the opportunity to make suggestions to the designers of other bridges, we have recommended strongly that scaffolding or its supporting track, generous compressed air facilities and access walks be installed at the time of construction. We know from our own experience that film thickness of paint is the life of the job. Experiences also indicate that one or two additional coats of paint shortly after the completion of the original job gave us, with our exposure and under our other conditions, greatly extended life on the original paint job. It is probably not necessary to say that the detail work of sealing cracks, seams, crevices, and other construction details and erection clearances is done better and with a minimum of disagreement and argument by our own forces than it could be done under a contract. We are not implying that a contractor would not do it, but realize the great difficulties which would be encountered in writing a contract to cover the multitude of details and the methods of payment for handling them.

The San Francisco - Oakland Bay Bridge is the headquarters of the State-Owned Toll Bridges organization which is under the general direction of James E. McMahon, Assistant State Highway Engineer, Bridges.

Howard C. Wood, Bridge Engineer, State-Owned Toll Bridges, has direct supervision of the toll bridge organization and is assisted by Thomas J. Dunn, Supervising Bridge Engineer. Edwin F. Levy, Senior Bridge Engineer, is in direct charge of maintenance operations. D. Ewing Marsh is Maintenance Superintendent, Painting. He is assisted by Clair Gibson and Roy H. Proffer, Structural Steel Painter Foremen, who have been with the organization since 1937, and to whom much credit must be given for the establishment of many of our routines and for the successful conduct of our program of preventive maintenance.

Dwight Wonacott

Dwight Wonacott, 62, Highway Maintenance Superintendent for the State Division of Highways in Fresno, died of a heart attack on September 19 while on vacation in Long Beach with his wife Georgia Ann.

A veteran of over 42 years with the Division of Highways, Wonacott began his career as a truck driver for the division in his home town of Bishop. He was promoted to superintendent while in Bishop more than 30 years ago, and had been with the Fresno office nearly 20 years.

He was a member of the Inyo Masonic Lodge No. 221 in Independence, Inyo County, the Order of the Eastern Star, the California State Employees Association, and the Quarter Century Club.

Besides his widow, he is survived by his brother, A. W. Wonacott of Bishop, and a sister, Mrs. Evangeline Troxel of Livermore.

Interstate Funds Total $228 Million

Apportionment of Federal-Aid Interstate Highway funds to the states for the fiscal year 1962-63 as made in August by Secretary of Commerce Luther H. Hodges provides a total of $2,400,000,000 to continue the program. This is the full amount authorized for the period by the Federal-Aid Highway Act of 1961.

California's share is $228,847,200. Last year it was $220,070,812.

The Federal-Aid Highway Act of 1961 authorized the appropriation of additional amounts for the Interstate System through the fiscal year 1971. The total additional funds authorized over the entire period, compared to existing authorizations, amount to $11,560,000,000. No changes were made in the amounts authorized (and already apportioned) for the fiscal years through 1961-62.

The latest cost estimate, approved by Section 102 of the 1961 Act, indicates that the total cost of completing the Interstate System will be $41,000,000,000, of which $37,000,000,000 is the estimated Federal share. This section increases the total amount authorized to be appropriated for this system from $25,440,000,000 to $37,000,000,000, adjusted to the fiscal years in which the estimated funds will be available in the Highway Trust Fund to cover the necessary disbursements. Under the present estimates, the amounts will be sufficient to complete the Interstate System by 1972.

Additional revenues were provided by the 1961 Act. A tax of 5 percent of the manufacturer's sales price of trucks, buses and trailers was increased to 10 percent, effective July 1, 1962. The tax on highway tires was raised from 8 cents to 10 cents per pound; on inner tubes from 9 cents per pound to 10 cents and on tread rubber from 3 cents per found to five cents.

A truck use tax on vehicles over 26,000 pounds was increased from $1.50 per thousand pounds to $3. An excise tax of 5 percent of the manufacturer's sales price of autobobiles and automobile accessories was repealed effective July 1, 1961.

Barstow Bypass

U.S. 66-91 Freeway Extended Nine Miles

By C. G. BEER, Assistant District Engineer and L. M. BARNETT, District Construction Engineer



On July 5, nine miles of the Barstow Freeway, known locally as the "Barstow By-Pass", were opened to traffic by construction contractors Gordon H. Ball and Ball & Simpson. The project is an extension of the 24-mile freeway from Victorville to Barstow which was opened in January, 1959. It makes available the improvement to full freeway standards of an important link of Federal Interstate Route 15 (U.S. 91) and the first step of freeway improvement of Interstate Route 40 (U.S. 66) toward Needles.

Construction of this $5,650,000 project was started in December, 1959, following a number of years of planning, design and right of way acquisition. Traffic surveys used in determining the route location had been started in 1953.



Main and First Streets in the City of Barstow, junction of old U.S. Highways 66 and 91.



The junction of U.S. 66 and 91 on the new freeway. Muriel Avenue Overcrossing is in the immediate foreground.

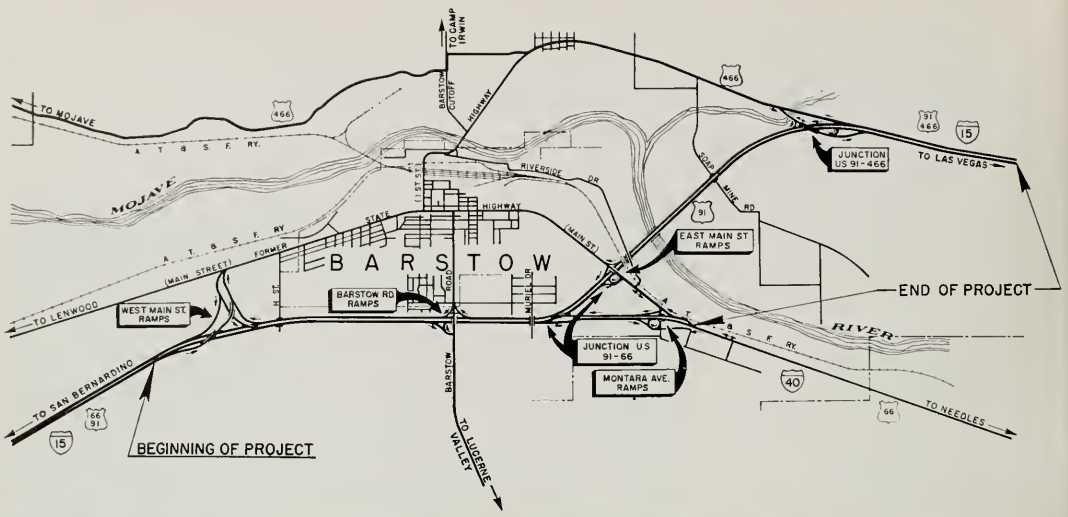
Noteworthy Changes

With completion of the "Barstow By-Pass", there are noteworthy changes in the routes to be followed by drivers on the several major transcontinental routes which cross in this area. The new pattern is indicated by shields on the map. U.S. 466, pending future connection to Interstate 15 on the west side of Barstow, now will make connections with U.S. 66 (Interstate 40) by way of the new Mojave River Bridge on U.S. 91 (Interstate 15).

The Mojave River Bridge was the major structure on the project. Although a dry-bed stream most of the time, the Mojave can carry considerable volumes. The photographs show flow in the 1938 flood, estimated to have reached 64,000 second feet; and in a tributary channel during a cloudburst storm in July, 1958. This tributary channel now crosses under the freeway east of Riverside Drive and can be seen in one of the aerial photographs.

Population Has Doubled

The City of Barstow now has a population of about 12,000, having approximately doubled in the ten years between 1950 and 1960. An official business route has been designated over the former State highway, with signs directing freeway traffic to the business section at the East and West



As indicated by the above map, the new freeway bypasses the downtown section of the City of Borstow.

U.S. 91 and 466 crosses the Mojave River to the City of Borstow in the background. U.S. 466 separates to the right in the lower left portion of the photo.



The Mojave River at Barstow during the storm of March, 1938.



Looking west from the junction of U.S. 66 and 91. A portion of the City of Barstow is to the right. The highway to Needles is lower left; highway to Las Vegas lower right.

Main Street Interchanges, and at the U.S. 91-466 junction north of the river. Concurrently with the freeway construction, the City of Barstow improved Barstow Road, the central north-south cross street, to provide a wide, illuminated arterial for easy access to the freeway from the center of the City.

Traffic surveys made prior to adoption of the freeway route showed that about 43 percent of the motor vehicles going through the City on the main line highways desired to make stopovers. Consequently, the location and design of the freeway was based upon providing direct connections to the central district as well as by-pass facilities for nonstop travelers. Other facts established by the traffic surveys were that U.S. 466 west of the City carried only about half as much total traffic and one-fourth as much through traffic as any of the other three legs. Consequently, the U.S. 466 freeway improvement was not included in the first stage project, but will be constructed later as traffic needs develop and funds become available.

George W. Savage

George W. Savage, newspaperman and former secretary of the California Highway Commission, died September 15 following a heart attack.

A native of Dennison, Iowa, Savage came to California in 1916. He attended high school in Pomona and was a graduate of Pomona College.

He served as managing editor of the Claremont *Courier* beginning in 1928; was co-publisher of the *Inyo Register* at Bishop and other Chalfant Press publications from 1933 to 1946; and published the South Pasadena *Foothill Review* from 1946 until he became secretary of the Highway Commission in January, 1948.

In September, 1949, Savage resigned from the Commission post to join the staff of James A. Guthrie, long-time Commission member and publisher of the San Bernardino *Sun and Telegram*, as manager of the Sun Printing and Publishing House.

He was active in the California Newspaper Publishers Association and various civic and fraternal organizations for many years, and at the time of his death had just completed his term as president of the San Bernardino Chamber of Commerce.

He is survived by his wife, Mary.

Contra Costa F.A.S.

Cummings Skyway, Taylor Boulevard Jobs Completed

By ROBERT LATCHAW, Assistant Public Works Director, Contra Costa County

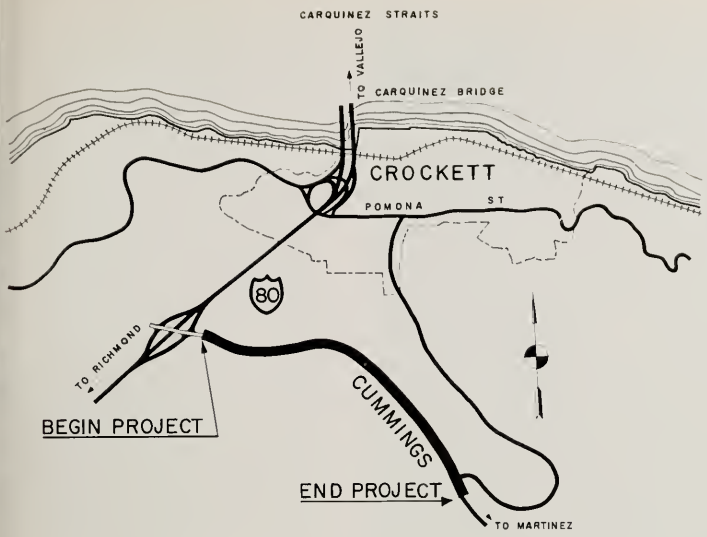
Contra Costa County's Federal-aid Secondary Program for 1961 included two major projects making the final connections in two routes designed to furnish collector service to the State Freeway System.

The first included a route through semi-mountainous terrain between Crockett Boulevard, located on high ground overlooking Carquinez Straits, and U.S. 40. Named in honor of former Supervisor H. L. Cummings of Contra Costa County, the new route (FAS Route 1256) now provides a short-cut line between Franklin Canyon Road (State Sign Route 4) and the U.S. 40 interchange and the approaches to the Carquinez Bridge.

The new facility provides two 12-foot traffic lanes and two 8-foot shoulders on one side of a roadbed graded for an ultimate four-lane divided highway for a distance of 1.96 miles and connects to a previous proj-



Looking eastword along the new section of the Cummings Skyway in Contra Costa County above the interchange connecting it with U.S. 40. Part of the "Big Cut" located just south of the twin Carquinez bridges can be seen to the left.



The heavy line on the above map shows the location of the new section of the Cummings Skyway.

ect 1.55 miles long completed by the County without Federal or State funds between State Sign Route 4 and Crockett Boulevard. The grade between U.S. 40 and Crockett Boulevard is continuously upward and the uneven topography required cuts and fills to 75 and 86 feet respectively.

Complex Drainage System

The project features a complex drainage and subdrainage system designed to cope with the problems created by highway construction in an area of extreme geological faulting and overturning. Preliminary soils investigations indicated that water would be found flowing or standing on hillsides, on ridge tops, and occasionally in the creeks.

To correct known drainage problems and to minimize the possible damage from undiscovered drainage situations, the project used about 17,000 feet of underdrains and about 24,500 tons of filter material. Over 6,700 feet of hydraugers were installed to drain wet cut slopes. Future slide probabilities were guarded against by eliminating sidehill cuts, and by using a combination of embankments buttressed against canyon walls and through cuts whose tops fell on the back slopes of the ridges. Nearly all surface drainage is carried in lined ditches or pipes to minimize erosion and reduce slope maintenance costs.

The construction contract awarded by the Division of Highways on December 3, 1959, to Parish Brothers, Benicia, California, was accepted as completed on January 19, 1961. Construction engineering was performed by the County personnel with continuous State and County Cooperation. A. S. Betts of Contra Costa County was the Resident Engineer.

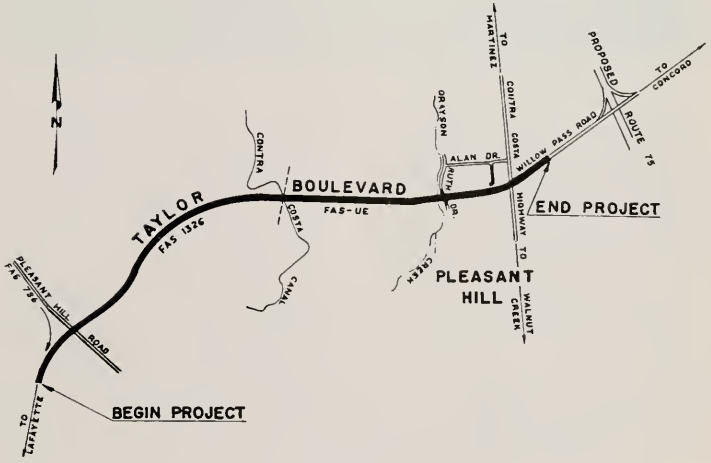
Cost Breakdown

Final cost distribution has not been completed but the preliminary cost breakdown will include Federal funds in the amount of $325,256 and State funds in the amount of $232,544 of a total estimated final cost of approximately $697,800.

The second project completed this year was Taylor Boulevard (FAS Route 1326) between Pleasant Hill Road and State Sign Route 21 at Willow Pass Road.

This is the second FAS Project on this County Thoroughfare and it completes the connection between State Sign Route 24 near Lafayette and State Sign Route 21 near Concord. Since the completion, in June, 1957, of the first unit of Taylor Boulevard which ended at Pleasant Hill Road, the need for the extension became more urgent each year. The new highway, which is an important part of the City-County Thoroughfare System, will provide a more direct route for local traffic and serve as a feeder for the State Freeways in the area.

Ultimately, when the traffic load justifies it, Taylor Boulevard will be



The new Taylor Boulevard project is indicated on the above map by the heavy line.



This westward view shows the intersection of Taylor Boulevard and State Sign Route 21.

a four-lane, divided highway for its full length between Pleasant Hill Road and Contra Costa Highway. The initial phase just completed provides two divided four-lane sections—a 0.41 mile section on the west end between Pleasant Hill Road and Apollo Way, and a 0.32 mile section from Grayson Creek to Contra Costa Highway on the east end. The intervening 0.55 mile section was paved for two lanes, but grading was done to provide for the eventual four-lane section.

Bridges Constructed

Two bridges and a reinforced concrete box culvert were constructed on this contract. The double 10-foot by 6-foot culvert on the north fork of Grayson Creek near Pleasant Hill Road, and the 50-foot span, pre-stressed concrete bridge across Grayson Creek near Ruth Drive, were built to carry four lanes of traffic. The third structure, a pre-cast, pre-stressed concrete bridge 45 feet in length across the Contra Costa Canal, provided a two-lane superstructure on abutments which were built to accommodate the four-lane bridge which will be required when the road is widened. Both bridges are supported by steel piles.

Three traffic signal installations were included in the contract. The original signals at Contra Costa Highway were replaced by a system designed to handle more directions of traffic movement. This intersection was reconstructed and traffic islands were built to channelize and separate all turning movements. New signals were installed at Ruth Drive to control pedestrian traffic at the school crossing and traffic entering the residential area. At Pleasant Hill Road, a fully channelized intersection, with signals, was constructed to distribute traffic smoothly through this juncture of two major County roads. All three signal installations have automatic, traffic-actuated controllers which proportion the amount of green time in relation to the volume of traffic approaching the intersection. Push buttons are also provided to control the "Walk"—"Don't Walk" pedestrian signals.

Total Cost

The total contract cost of constructing this project is estimated to be $779,332. Federal and State highway aid funds will provide approximately $445,500, while the County's share of the cost is $333,849. This was the first County road project in California to receive funds from the State Highway Commission under the new program for Federal Aid Urban Extensions.

The accompanying photographs show Taylor Boulevard intersecting Pleasant Hill Boulevard and its extension crossing State Sign Route 21 in the Urban Area west of the City of Concord.

Cooperation in the planning and design phases of the project was received from the City of Concord and the State Division of Highways. The firm of Gallagher and Burk, Inc., of Walnut Creek was the contractor with Larry Ashworth as Project Superintendent. The project was completed two months ahead of schedule.

The County Public Works Department, directed by Victor W. Sauer, was represented on this project by Resident Engineer John L. Shotwell.

Talking About Highways — *Comments from Here and There*

Progress on Interstate

The following editorial appeared in the *Hayward Daily Review:*

"California receives a nice compliment in the current issue of *The Saturday Evening Post* which carries an article on the nation's 41,000-mile interstate highway system.

"Although California lags far behind Oregon and Washington in completed mileage on the new I-5 inland coast route from Canada to Mexico, there is a good reason for it.

"In the first place, as the article points out, the two northern states tackled the rural stretches at the outset. California chose to work first on the urban sections.

"With the rapid expansion of California's metropolitan areas, it makes good sense to move as quickly as possible to minimize conflicts between city growth and highway progress.

"In addition, the *Post* article points out that California has acquired more right of way mileage ahead of need than any other of the states.

"The acquisition of rights of way can be one of the most delaying factors in a highway program. California's early attention to that detail could prove a spur to more rapid construction later.

"This state has been remarkably free of highway scandals, with no charges of graft or corruption regardless of whether Democrats or Republicans were in power in Sacramento. Some sections of the east and midwest have not been so fortunate, but it is good to read that the charges are broadly untrue.

"A number of predictions are made in connection with the interstate system. It will save lives. It will save time. It will save money. As residents of a state noted for its mobile population, Californians can appreciate all of those."

Balanced Transportation Network

This statement was included in the final report of consulting engineers hired by the San Francisco Bay Area Rapid Transit District to prepare proposals for a regional transit system:

"No one mode of transportation by itself can provide completely and economically for the movement of people. A balanced network of transportation facilities is essential.

"The (proposed) regional rapid transit system will form an important and integral part of the total transportation facilities of the San Francisco Bay Area.

"The networks of freeways, local streets and local transit routes are all essential elements. By themselves, however, they cannot carry the entire mounting burden of traffic, particularly in the periods of peak demand.

"Together, these networks and the rapid transit system mutually complement each other and afford the Bay Area the best prospect for a balanced and economical combination of circulation facilities."

Freeway At Dunsmuir

"Wonderful! Beautiful! Real Choice! . . . are only a few of the superlatives that can be overheard on the streets of Dunsmuir when the tourists and vacationers are in town shopping, eating, enjoying the several beautiful fountains on our streets.

"About a year ago the hue and cry seemed to be that of dismay and anticipation . . . what would happen to Dunsmuir when it goes off the Freeway.

"Up the canyon we would even hear some of the people say 'poor Dunsmuir' is about done, and 'looks like Dunsmuir is about washed up.'

"Well here it is July, 1961, and for the most part the merchants, townspeople, out-of-towners and our visiting friends are mighty happy with the 'change' in Dunsmuir with the disappearance of the thundering traffic on Florence Avenue.

"In fact, say so many, you can talk on the street now and not be afraid of being murdered by a 40-ton logging or transport truck.

"Merchants are almost unanimous that their business is going on, and a number are very happy with the new and increased volume of business this year."—"Strolling Down the Canyon" column in the *Dunsmuir News.*

William T. Rhodes

William T. Rhodes, Division of Highways engineer who retired in February, 1960, died in San Diego on July 5.

Rhodes had been with the Division 39 years prior to his retirement and had served as resident engineer on numerous construction projects in central and southern California. His career covered a period in highway development which saw some of its greatest change and growth. He served as resident on projects ranging from two-lane desert highways to complex full freeway sections in the San Diego area.

Rhodes developed several aids to highway engineering during his career. These include the "Rhodes Arc" for rapidly calculating the relationship of horizontal to slope distance for surveyors; the "Ready Reckoner" for determining pavement depth during construction; and a type of temporary striping which can be glued to new paving with asphalt binder to delineate traffic lanes through new construction.

Rhodes was a native of Texas. He was a member of the Masonic Lodge at Mariposa.

He is survived by his wife, Marguerite; a daughter, Mrs. Ione Higgins; a son, William T., Jr., all of San Diego, a brother and four grandchildren.

U.S. 80 at El Cajon

Two New Freeway Sections Opened This Year

By J. A. JESPERSON and V. LEFTWICH, Resident Engineers



The completion this year of two three-mile projects in El Cajon, both by the Griffith Company, and the completion early next year of a 2.3-mile contract in La Mesa, will provide the missing links to 17 miles of full freeway on U.S. 80 extending from U.S. 101 in San Diego to the easterly limits of the city of El Cajon. This stretch of freeway ends at westerly terminus of U.S. Interstate Route 8 and in fact, is only the beginning of a major construction program in District XI that ultimately will see this route improved to freeway standards as far as the Arizona border, 160 miles east.

The first work by the Division of Highways through El Cajon Valley was done in 1915. A strip of concrete pavement 30 feet wide by several blocks long was laid through the busiest section of the little town. Some years later in the '20's an 18-foot-wide strip was continued easterly across the valley and westerly to La Mesa. Along this route the city's business developed.

Last Improved 1935

It was not until 1935 that traffic had increased enough to justify further improvements of the route and in that year, within the then city limits, U.S. 80 was widened to a total of 76 feet, providing diagonal parking on both sides.

During the late '40's and the fabulous '50's, El Cajon city sprang from a sleepy little town of 3,000 people to a bustling traffic-congested city of 35,000. Main Street and Magnolia Avenue, the junction of U.S. 80 and State Route 67, became a major traffic bottleneck. Local San Diego commuters, tourists from the east, and heavy truck traffic from the rich farms of Imperial County were funneling through this intersection compounding the city's traffic problems. The opening to traffic in May of this year of the first of the two El Cajon contracts already has relieved considerably the city's congested traffic.

Beautiful Panaramic View

El Cajon, named by the early Spanish settlers, signifies "the box" and is



An aerial view of a portion of the U.S. 80 freeway in El Cajon, taken during the ribbon-cutting ceremonies on September 6. View is west, toward San Diego, with four-quadrant interchange at Magnolia Avenue (State Sign Route 67) in distance. Cars and marching units for ceremony are shown near Mollison Avenue interchange. Drainage channel at right was constructed as part of freeway contract through cooperative agreement with city of El Cajon.

descriptive because the valley is boxed in by mountains and hills. The section of freeway completed in May, from Chase Avenue to Ballantyne Lane, enters the valley along the slopes of the westerly hills and for a distance of approximately two miles provides the motorist with a beautiful panoramic view of the entire valley. At night when the city is ablaze with colorful neon lights the view is tremendous.

The new alignment of U.S. 80 bypasses the city's business district to the north about five blocks, and through the heart of the city parallels old U.S. 80.

Contract Began 1959

Work began on the first freeway contract in El Cajon in December 1959 and was completed in May 1961 at a cost of $2,770,000. The second contract got under way in May of 1960, and was completed in September 1961, at a cost of approximately $3,000,000.

Both contracts consisted of grading, placing selected bases, surfacing with concrete pavement, and constructing drainage facilities and reinforced concrete bridges. Both were designed and constructed for ultimate 8-lane developments. However, on the first contract only six lanes were paved and on the second contract only four.

Over 2,000,000 Yards of Fill

Roadway embankment for the contracts was obtained from three sources. First, some 500,000 cubic yards of excess roadway excavation came from the so called "Grossmont Summit" job and were placed on portions of both the contracts before either of them was let. Second, 410,000 cubic yards of roadway excavation were developed from cuts within the limits of the work. And third, 1,250,000 cubic yards of Imported Borrow were taken from a privately owned borrow site located near the center of the first contract on a hill overlooking the valley.

In order to schedule the Imported Borrow of the two contracts in a work-wise manner, the Division of Highways made available to the contractor a haul road on private property, over which it was permissible for him to haul over-legal loads. Along



An aerial view looking northeasterly along realignment from Grossmont Summit where new freeway gradually drops to valley floor. Black road is old highway which goes through center of city.



A ground level view showing same section as in aerial above, at later stage in construction. Old road gives access to business section. This portion of freeway was opened in May of this year.

the route, as many as nine city streets had to be crossed, which presented to the contractor a major traffic handling problem. The volume of his own traffic was high. As many as 26 rubber-tired earthmovers, some of 40 cubic yards capacity, were hauling an average of 12,000 cubic yards of imported borrow to the job in an eight-hour shift.

Traffic Safety Precautions

To protect the traveling public, at least one, and often two flagmen were stationed at each crossing. Flagmen were equipped with two hand-operated, battery-powered, flashing, eight-inch stop lights, for each direction of public traffic. The lights were mounted on 4' x 5' warning signs that were placed near the edge of the traveled way during hauling hours. At one major street crossing, State Route 67, a full sized traffic signal system was installed.

In addition to protecting the motorist, there was the problem of protect-

ing children that crossed the haul road to attend the Johnson Avenue, Naranca, and Bostonia grade schools. Meetings were held with the superintendent of schools, principals, and parents. As a result, the children were made aware of the dangers, special signs, barricades and barriers were placed to define crossing points, and flagmen, whose sole duty was to watch after the children, were stationed at each school crossing.

Water a Problem

Obtaining an adequate water supply for compacting earthwork presented somewhat of a challenge to the contractor. Water mains, overtaxed by the city's mushroom growth, plus subnormal rainfall for many years, created a real water shortage. The problem was finally solved, however, by pumping reclaimed water from the El Cajon sewage plant located about three miles from the junction of the two contracts.

Construction of drainage facilities constituted a considerable portion of the contract, due largely to the fact, that across the floor of the valley the freeway coincides with the valley's natural drainage, Forester Creek. Thru a cooperative effort of the City of El Cajon and the Division of Highways, drainage facilities were included in the contracts to accommodate not only the freeway needs, but also the city's master plan for future drainage. A concrete-lined channel, averaging ten feet deep by thirty feet wide and three miles long, was constructed adjacent to portions of the freeway. Thirteen large box culverts were constructed. Eight carry channel water under the cross streets. The other five take water under the freeway from the City's drainage system to the channel.

Ten Bridges

Ten twin box girder bridges were built on the two contracts. Four are diamond type interchanges that were located at West Main, Mollison, Second and East Main Streets. Five simply span cross streets and two railroads, with no ramp connections. The largest bridge is a full four leaf clover design with collector roads crossing State Sign Route 67, Magnolia Avenue.

Base materials were obtained from decomposed granite deposits located in the nearby hills to the northwest and were hauled to both contracts by Asbury Contractors Inc. of Los Angeles. An average of 14 bottom-dump trucks and trailers were used to deliver approximately 4500 tons per eight hour shift. The top four inches of the base was treated with cement.



A slip-form paver in use on recently completed section of freeway in El Cajon.

Slip-Form Paving

On the second contract the contractor used the new Guntert-Zimmerman machine to trim the CTB and to slip-form pave the concrete pavement. Since an excellent description of this machine was given by Mr. Leigh S. Spickelmire in the January-February 1960 issue of this magazine, no attempt is made here to describe it. Noted, however, are certain modifications that were made recently which have greatly improved the machine's ability to lay an acceptable slab.

On previous paving jobs this machine has not been able to consistently lay a pavement slab, smooth enough to meet our requirements, without a considerable amount of expensive grinding. The cause of roughness was attributed to at least two factors. First, the fresh concrete, as it went through the machine, tended to surge at the back of the screed and occasionally caused the screed and floating section of the machine to be lifted far above grade. And second, the fresh concrete was not being thoroughly compacted, which resulted in differential settlement of the concrete.

To correct these problems three steps were taken. First, the feed hopper was lowered about two feet, which decreased the concrete head and consequently the upward pressure of the concrete on the screed. Second, in order to increase consolidation of the concrete, a row of eleven equally spaced, longitudinal internal vibrators was installed at a point ten inches in front of the screed. And third, to further assist consolidation a metal plate, extending the full width of the screed, was placed in the feed hopper just in front of the external vibrator in such a position as to form an escape hatch for entrapped air that formerly was causing problems under the screed.

Changes Improve Profile

The results of these changes are very encouraging. Since they were made, approximately six miles of 24 ft. wide pavement have been laid with no



ABOVE—Looking southerly along U.S. 80 fill section in El Cajon residential area. Photo made in February, 1961. Overcrossing in middle distance is Second Street, with Grape Street pedestrian overhead just beyond. Primary purpose of this overhead is to serve school children.



RIGHT—Magnolia Avenue interchange here shown during construction period is designed for heavy traffic. Magnolia Avenue north of U.S. 80 is State Sign Route 67 which eventually will be rebuilt as full freeway to carry traffic northward to Ramona area.

daily average of the profile indexes exceeding the rate of 7.0 inches per mile. The average daily index for the entire job was 2.8 inches per mile. The lowest reading for one day's run was 0.7 inches per mile.

In order to meet the smoothness requirements a small amount of grinding will be necessary at fourteen locations. However, at ten of these spots the cause of roughness is not directly attributable to the slip-form paver.

One other interesting change that developed during the paving operation was the complete elimination of trailing slip-forms. When paving began 45 feet of trailing forms were attached to the machine. Edges were slumping badly. As an experiment 15 feet of these forms were removed. Immediate improvement was noticed. It was then decided to remove the remaining 30 feet to see what would happen. The results were phenomenal. Edge slump was completely eliminated. Where four men were needed to finish the edges now the work could be done easily by two. It then became apparent that with a slight modification of the machine's side forms, or the addition of special edging tools attached to each side form, hand work on the edges could be eliminated.

Trailing "V" Float Eliminated

One additional change, the elimination of the trailing "V" float, is noted. With the trailing forms gone nothing remained to hold this float in correct position. Consequently, it was decided to experiment further by removing the float. No appreciable change was noted in the amount of hand work required to obtain a comparable finish. Accordingly, the float was discontinued permanently.

With the removal of the "V" float, the finishing effort behind the paver, except for edging, was accomplished by two men pulling a 4″ by 40′ aluminum pipe. Minor surface deviations were removed with this pipe by placing it across the concrete at about a 45° skew and floating it back and forth longitudinally on the surface of the concrete.

Texturing of the surface was accomplished in the conventional way by pulling two burlap drags over the freshly finished concrete.

Griffith Company's superintendent on the Chase Avenue to Ballantyne Lane contract was Frank Moody. Victor Leftwich was Resident Engineer for the Division of Highways. On the contract between Magnolia Avenue and 0.7 mile east of Third Street the Griffith Company was represented by two superintendents, Lloyd Leonard and Frank Moody. J. Avril Jesperson was Resident Engineer for the Division of Highways.

Routes Adopted

Highway Commission Acts On Rural, Metropolitan Routings

Thirteen freeway routes in areas ranging from Humboldt to San Diego Counties and embracing both rural and metropolitan areas were adopted by the California Highway Commission in July and August.

The future freeway complex in the Sacramento metropolitan area was further delineated by the adoption of a route for 19.3 miles of State Highway Route 247 (Arcade Freeway) between U. S. Highway 99-50 near the Cosumnes River and Engle Road in the northeast area.

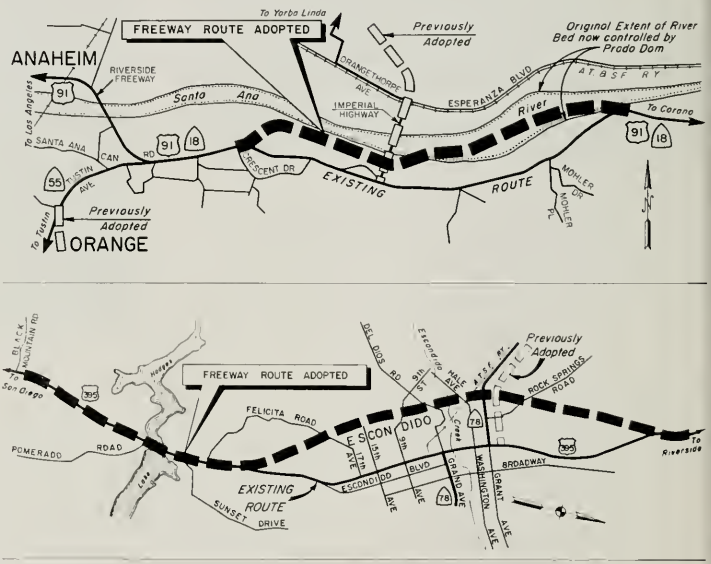
Orange County

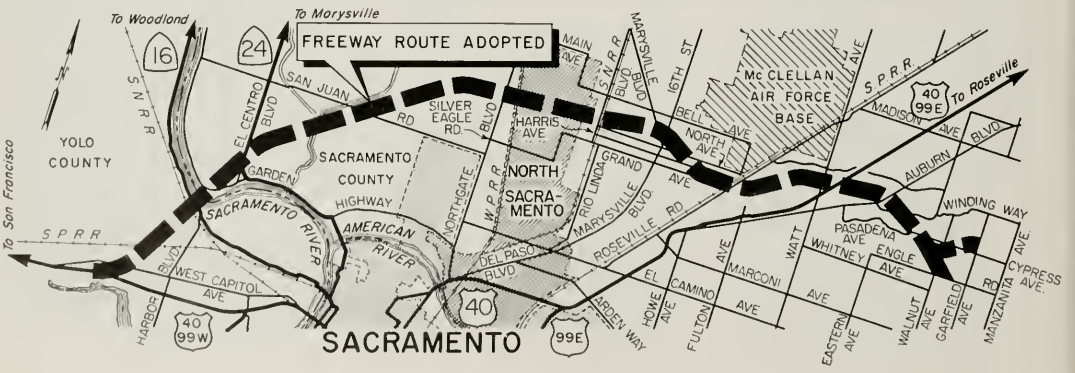
In Orange County, a route for the relocation of 3.7 miles of U. S. Highway 91 (Riverside Freeway-Santa Ana Canyon Road) was adopted, based on the recommendation of State Highway Engineer J. C. Womack and the results of a public hearing held by the Commission in Santa Ana on July 26. The route runs north of the existing highway eastward from Crescent Drive to a junction with the existing highway eastward from Cresent Drive to the existing highway 2.3 miles east of Imperial Highway.

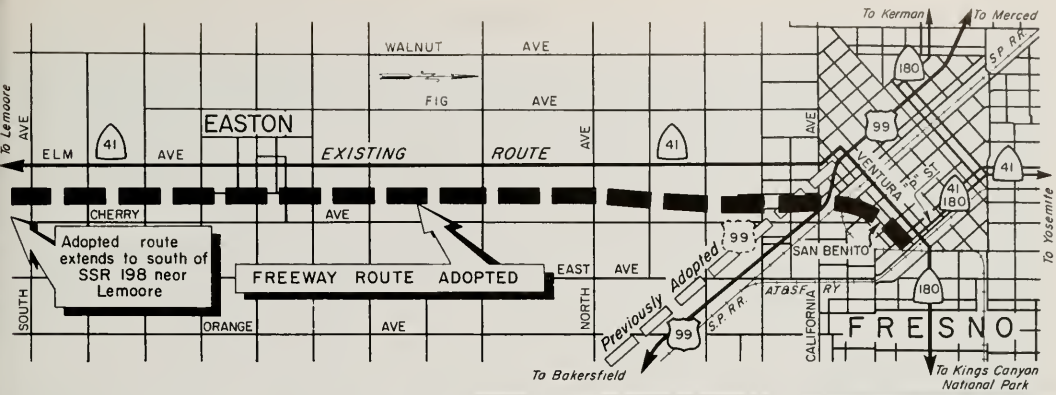
A route was adopted for the relocation of 10.6 miles of U.S. 395 in the vicinity of Escondido extending from 2.2 miles south of Lake Hodges to 3.3 miles north of Grant Avenue in Escondido. The adopted route follows the existing highway to about a mile north of Lake Hodges, then swings about four-fifths of a mile west to bypass the main section of Escondido.

South of Fresno

In and south of Fresno the Commission adopted a route providing for a future 34 miles of freeway on State Sign Route 41 in Kings and Fresno Counties. It extends between Jersey Avenue south of Lemoore in Kings County and P Street in the City of Fresno. The adopted route follows the existing road in Kings County with the exception of a relocation between Jersey and Jackson Avenues to elimi-







nate two right-angle turns. In Fresno County the route is on new location generally about a quarter of a mile east of the present highway. It enters the City of Fresno between Kirk and Rose avenues, swings northeasterly and occupies the block between San Benito and Santa Clara Streets.

Other adoptions:

State Highway Route 56 in Humboldt County between Van Ness Avenue in Ferndale and the west end of the Eel River Bridge at Fernbridge.

U.S. Highway 66 in San Bernardino County between Barstow and Newberry.

Sign Route 4 in Calaveras County in the vicinity of Arnold and between west of Dorrington and Camp Connell.

Sign Route 36 in Plumas County between 1.5 miles east of Chester and the Plumas-Lassen County line.

U.S. 99 in Shasta County, minor changes in the previously adopted route just south of O'Brien and between Black Oak Summit and Antler Summit.

Sign Route 154 in Santa Barbara County between Surf and the west city limit of Lompoc.

Sign Route 198, along the existing highway east of Visalia.

U.S. 6 in Los Angeles County between U.S. 99 and 0.8 mile west of Sand Canyon Road.

U.S. 395 in Mono County between Bridgeport Ranger Station and Devil's Gate.

BRITISH RESEARCH HEAD VISITS LAB



During his visit to the United States for various technical meetings, Sir William Henry Glanville, Director of Road Research for Great Britain, made a special trip to Sacramento on September 8 to inspect the Materials and Research Laboratory of the Division of Highways. He is shown above, at right, examining the Division's marking profilograph. Others in the photo, left to right, are George B. Sherman of the Materials and Research Department; Materials and Research Engineer Francis N. Hveem; and J. O. Grasberger of District IV. Sir William was accompanied to Sacramento by John F. A. Baker, Chief Highway Engineer for the British Ministry of Transport and Civil Aviation. Mr. Baker spent the day conferring with planning officials of the Division of Highways.

The California Highway Commission approved ten projects on Federal Aid Secondary County Roads with a total estimated cost of $2,482,000 at its September meeting.

The California Highway Commission has allocated $2,313,150 in state highway funds toward the cost of railroad grade separation projects on local city streets and roads.

CONSTRUCTION PROBLEMS TACKLED AT 2-DAY MEET



The volume and assortment of documents on the conference table give some idea of the size of the agenda for a two-day meeting of district engineers and assistant district engineers held in Sacramento in July. Contract and inspection procedures, specifications and other problems were intensively discussed. Those participating (Assistant District Engineer for Operations unless otherwise identified) were:

Seated around table, reading clockwise: G. L. Richardson, District XI; W. Z. Hegy, District I; C. C. Winter, Construction Engineer (North), Bridge Department; E. L. Miller, District III; Haig Ayanian, Assistant District Engineer—Construction, District IV; W. M. Nett, District II; Milton Harris, Construction Engineer, Division of Highways, Sacramento; L. R. Gillis, Assistant State Highway Engineer—Operations, Sacramento; C. A. Shervington, District Engineer, District IX; George Wafford, District V; F. M. Raush, District VI; L. A. Weymouth, District Engineer—Operations, District IV; A. L. Himelhoch, District Engineer—Operations, District VII; F. B. Cressy, Assistant District Engineer—Construction, District VII; E. G. Bower, District VIII.

Standing, rear, E. L. Tinney, District X (left) and State Highway Engineer J. C. Womack. Seated, rear, M. H. Mitchell, Assistant Construction Engineer, Sacramento (left), and Deputy State Highway Engineer J. P. Murphy.

John M. Paley

John M. Paley, 63, Chief Clerk for the Division of Highways in Shop 6 at Fresno died suddenly of a heart attack on July 9th.

Paley started with the State in 1934 as a Senior Account Clerk in District VI in Fresno and was promoted in 1938 to Supervising Account Clerk I, and in 1944 to Supervising Account Clerk II while serving as Chief Clerk of Shop 6.

Paley was born in Bristol, Rhode Island. His family soon moved to Tacoma, Washington. He later graduated with a B.A. degree in Business Administration from the University of California in Berkeley.

Paley served for four years in the U. S. Navy during World War I. He was a member of Sun Garden Masonic Lodge No. 530, Royal Arch Masons, the Quarter Century Club and the First Presbyterian Church.

His survivors include a son John E. Paley, a daughter Mrs. Ruth Ann Darter and one grandchild, all of Fresno. His wife recently died after a long illness.

Department Announces Recent Retirements

Headquarters Office

Lessley D. Wance, Supervising Highway Engineer, 32 years.

District I

William G. Grauman, Groundsman, 12 years; Elvin Houx, Laborer, 27 years.

District II

Bertha Garrison, Intermediate Stenographer, 13 years; Manuel V. Salvador, Light Power Shovel Operator, 37 years.

District VII

Edward F. King, Senior Right of Way Agent, 23 years; Wm. D. Sedgwick, Supervising Highway Engineer, 32 years; Harold S. Throckmorton, Associate Right of Way Agent, 32 years; Ralph Truesdale, Senior Highway Foreman, 27 years.

District IX

Clarence H. Haus, Laborer, 21 years.

District X

Fred Narcisso, Highway Equipment Operator Laborer, 36 years.

Chamber Submits Highway Recommendations

The Statewide Highway Committee of the California State Chamber of Commerce appeared before the California Highway Commission in San Francisco on August 24 to submit for the thirtieth time its annual list of state highway project recommendations for consideration in budgeting and future planning.

The list, compiled after a series of local meetings all over the state, encompassed 783 projects, grouped into three categories. Those in the "A" category included projects on which engineering had been completed to the extent necessary to qualify them for right of way or construction funds. The "B" category included projects recommended for surveys, design or initial right of way acquisition, and the "C" category covered projects recommended for long-term planning.

In introducing the six regional chairmen and vice-chairmen who presented the recommendations for their respective areas of the state, Vice-Chairman Joseph A. Moore of the statewide committee called particular attention to the unique character of the State Chamber's program in the highway field.

"It is the only program we know of in the United States," he said, "where any organization in any state, private or otherwise, goes into counties or areas throughout the state and holds meetings to determine the viewpoints of the people of business, agriculture and industry on what they desire to see done to improve their highway transportation program."

An exhibit displayed to the Highway Commission showed that in 1961 the list of project recommendations was distilled out of a total of 50 local meetings, attended by a total of more than 3,000 persons.

The meetings, planned by the Chamber's district managers, required coordination with some 500 official and civic bodies. They were attended by not only the local and regional organizations, but also by Assistant Director of Public Works T. F. Bagshaw, by the local District Engineer of the Division of Highways and by a representative of the Sacramento headquarters of the Division. C. Clarke Williams, manager of the Highway and Transportation Department of the State Chamber, also attended all the meetings.

Moore also pointed out that the State Chamber's program, in addition to providing a "common meeting ground" at which community leaders can "get together on a unified and solid State highway program," also serves to keep the local groups informed and aware of the highway problems and needs of the entire State.

Members of the Commission and State Highway Engineer J. C. Womack commended the State Chamber group on the thoroughness of the program and the work which went into it.

IN MEMORIAM

Headquarters Office

James R. Smith, Senior Right of Way Agent

District III

Richard W. Thornburg, Highway Engineering Technician I

District IV

Ernest P. Prielipp, Highway Leadingman

District VI

Cecil R. Smith, Highway Foreman

District VII

Abram N. George, Jr., Senior Highway Engineer

Bridge Department

Edgar G. Tuck, Assistant Bridge Engineer

Frederick M. Wilhite, Bridge Painting Inspector I

Shop 6

John M. Paley, Supervising Account Clerk II

Shop 8

Miles H. Lawrence, Automobile Mechanic

State Takes Over Former County Roads

The California Highway Commission has accepted six former county roads for maintenance as part of the State Highway System.

According to law, the State assumes responsibility for maintaining such roads when acceptable design and construction standards have been met.

The new state-maintained routes are:

Shasta and Lassen Counties—Feather Lake Highway (State Highway Route 20) between Sign Route 89 at Old Station, Shasta County, and Sign Route 36 west of Susanville. This 46.1-mile route is included in California Freeway-Expressway System.

Plumas and Lassen Counties—Lake Almanor East Side and Clear Creek Roads (State Highway Route 183) between Sign Route 89 at Canyon Dam, Plumas County, and Sign Route 36 west of Westwood. This former county highway is nine miles long, and generally follows the east shore of Lake Almanor. It was added to the state highway system by the 1961 Legislature.

Kings County—Central Valley Highway and 10th Avenue (State Highway Route 135) between Sign Route 198 east of Hanford and the Fresno County line, a distance of nine miles. This route was added to the state highway system by the 1961 Legislature.

San Bernardino County—Two sections of Twentynine Palms Highway—10.5 miles (State Highway Route 187) between East Road in Morongo Valley and Old Woman Springs Road near Yucca Valley, part of the California Freeway-Expressway System; and 21.7 miles (State Highway Route 218) between Old Woman Springs Road near Yucca Valley and Utah Trail Road in Twentynine Palms, added to the state highway system by the 1961 Legislature.

Riverside County—Cahuilla Road (State Highway Route 277) between Sign Route 79 near Aguanga and Sign Route 74 east of Anza, 21 miles, included in California Freeway-Expressway System.

HIGHWAYS STATE FAIR EXHIBIT IS AWARD WINNER



The Division of Highways exhibit at the 1961 California State Fair in Sacramento was devoted to various aspects of highway planting. It occupied a 30-foot-wide space in the educational area, opposite the Hall of Flowers, and featured nursery specimens of plants frequently used on highway planting projects. Streamers led from the plants to large photographs showing how each plant fitted into an actual planting situation.

Also included in the exhibit was an eight-foot Bridge Department model of a typical landscaped section of elevated urban freeway. In the above picture, Dick Roberts of the Headquarters Roadside Development Section, is shown pointing out features of the model to a young fairgoer. Roberts and other members of the Roadside Development Section and the Maintenance Department took turns manning the exhibit and answering questions.

The display was designed by J. J. Rolph of the Audio-Visual Section and constructed by William Van Sherman and Angelo Venturini of the Service and Supply Department. Judges awarded the booth a plaque for "structural beauty and outstanding educational exhibit."

Copies of the reprint booklet "California Roadsides," containing the four articles on this subject which appeared in this magazine earlier this year, were distributed at the exhibit to interested persons.

Legislation Includes New Highway Fund Formula

Several significant measures affecting State highway expenditures, route adoption procedure and toll bridges were passed by the State Legislature during its 1961 session and signed into law by Governor Edmund G. Brown.

Allocation of Funds—The "Mayo formula" governing minimum State highway construction expenditures within the respective counties will expire on June 30, 1953. It was originally enacted in 1947 as part of the Collier-Burns Highway Act. Senate Bill 1412 (Chapter 1376) of the 1961 session provided a more flexible formula, based on the eleven State highway districts rather than individual counties; however, the expenditures in each county must amount to at least $4,000,000 in each four-year period (except in Alpine and Sierra Counties, where this minimum is $1,000,000). The "north-south split", requiring that 55 percent of the construction monies be spent in the southern group of 13 counties and 45 percent in the 45-county northern group, was not changed.

Right of Way—The revolving fund for advance acquisition of rights of way, established by the Legislature in 1952 and scheduled to terminate in 1962, has been extended by Senate Bill 557 (Chapter 1637) for another ten years. This fund enables the Division of Highways, upon approval of the Highway Commission, to purchase property far in advance of future freeway construction if improvement of the property, making it more costly, is imminent.

Route Adoption Procedure—The Highway Commission's long-established policy of advance public discussion and information and cooperation with local officials in connection with freeway route location matters is expressed and recognized as a part of the Streets and Highways Code (Article 6, Section 210). This is covered in Senate Bill 1335 (Chapter 1371), which also provides for inclusion of the Commission's procedural resolution of February, 1958, (and any future revisions of it) in the California Administrative Register.

Coronado-San Diego Crossing—Included in the Budget Act of 1961 is an appropriation of $525,000 of State Highway Fund monies for traffic, revenue and design studies for a toll crossing between Coronado and San Diego.

San Francisco-Marin Crossing—The Department of Public Works is required by Senate Bill 1273 (Chapter 2142) to study a proposed crossing between San Francisco and Marin County by way of either Angel or Alcatraz Island. The measure makes $500,000 available from the State Highway Fund for the study.

San Mateo-Hayward Bridge — Previous legislation permitting the use of San Francisco-Oakland Bay Bridge revenues to finance the four-laning of the San Mateo-Hayward Bridge is extended for another 18 months to June 30, 1964 by Senate Bill 1016 (Chapter 2076), to make possible the construction of a high-level fixed span over navigable waters rather than a low-level movable span if such a change is found permissible and feasible.

Safety Study—Senate Bill 1217 (Chapter 2110) appropriate $100,000 from the Motor Vehicle Fund for research on highway safety, to be conducted jointly by the Division of Highways, the Highway Patrol and the Department of Motor Vehicles.

Open House

Public Inspects New Highways Building in San Bernardino



The District VIII Office held Open House in San Bernardino on August 8 to acquaint the public with its newly expanded facilities.

The extensive areas involved precluded conducting guided tours; hence, the affair was planned on the basis of making it convenient for guests to readily locate any department or office desired. This was effected by means of temporary signs in the corridors, presentation to each guest as he registered of a brochure including labeled plans of the buildings, and the cooperation of hostesses handling information centers at various locations.



A view of the front entrance of the new Highways building in San Bernardino. Tiled-roof section to the left was constructed in 1952.



Guests register in the lobby prior to touring the new Highways building.

Department Displays

Each department planned and handled its own displays, which were generally designed to picture the department's contribution to the over-all efforts involved in planning, construction, and maintenance of State highways.

Motion pictures and film strips were run continuously on a scheduled basis, providing a general outline of the functions and problems of the Division of Highways.

Displays of surveying methods and equipment, landscaping plants, interchange models, utilities clearance of Right of Way and the Reproduction Section's equipment and methods seemed to evoke special interest among visitors.

More Than 800 Guests

Refreshments were served to both guests and employees in the new cafeteria through the courtesy of Chapter 7 of CSEA and the Highway Engineers' Club.

Approximately 800 guests visited the building during the 1-6 p.m. period. The enthusiasm evidenced by the employees in planing and executing their displays was reflected by obvious appreciation of the guests and a number of favorable newspaper reports.

Marsh Area Fill

Sand Drains Aid in Soil Stabilization

By L. E. DANIEL, Resident Engineer and W. G. WEBER, Associate Materials and Research Engineer



Numerous sand drain projects have been constructed throughout the world since the vertical sand drain method of treatment for soft foundation soils was patented by Daniel E. Moran in 1925. The complete mathematical analysis for theoretical solution of the consolidation of soils by sand drains was published in 1947 by Reginald A. Barron. There are still uncertainties in calculating the rate of consolidation and the resulting increase in strength of the foundation soil when using sand drains; that has resulted in some unsuccessful sand drain projects. It was desired to obtain additional information on the operation of sand drains to decrease some of the uncertainties in the use of sand drains by building a full-scale fill as a test section.

How Sand Drains Operate

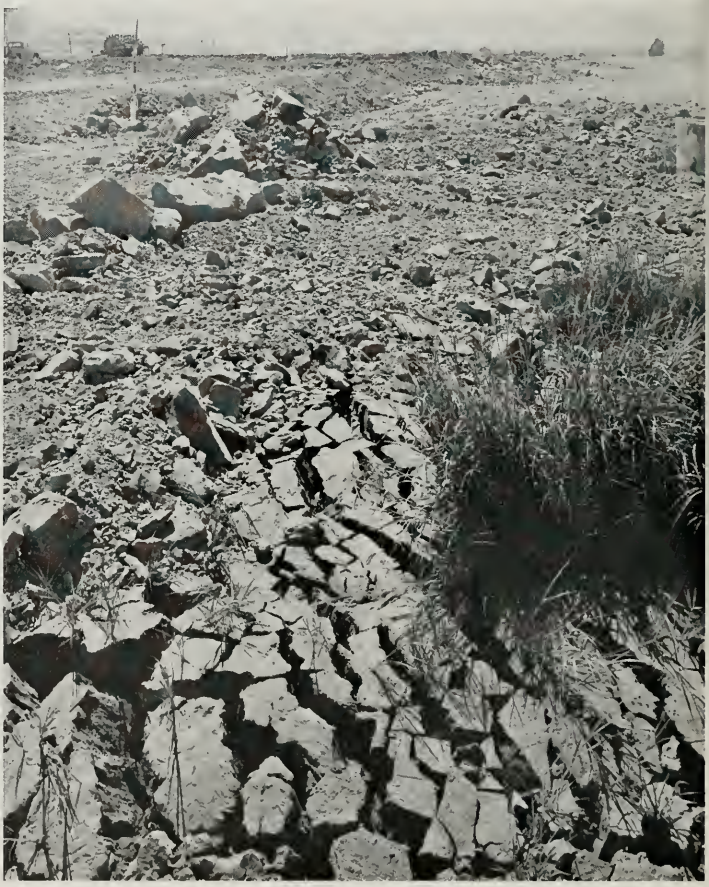
Saturated soft soils and peats are usually so weak that even small fills or other loads sink considerably while the soft soils are being pressed somewhat like a sponge. As with a sponge that is saturated with water, pressing or squeezing forces the water out. The soil has pores so fine that they can scarcely be seen under a powerful microscope. These small pores offer so much resistance to the flow of water that it may take 50 or 100 years depending upon the length of drainage path, to squeeze the small amount of water out of the soil by the applied load. The rate at which water is pressed out of the soil varies with the square of the drainage path. As the water content of the soil decreases the shearing strength of the soil is increased.

Sand drains are vertical columns of sand placed at regular spacing through the soft compressible layer. A pervious blanket is placed over the sand drains so that the water is removed from the fill area. Sand drains shorten the drainage path, thus greatly increasing the rate at which consolidation occurs.

Sand drains thus perform two related functions: (1) increase the rate of consolidation of the foundation soil, thus decreasing the settlement after construction of the fill, (2) increase the height of fill that can be built by increasing the strength of the foundation soil.

Design of Sand Drain

The foundation soil in the area of the west approach to the Napa River Bridge on State Sign Route 48 in Solano County consisted of "soft bay mud" to a depth of 60 or 70 feet, with a firm silty clay underlying the soft bay mud. The natural water contents



A general view of the project looking west. The mud "wave" in the foreground was caused by the placing of the strut.



This photo shows the temporary detour being constructed to the right of the existing highway. The main portion of the fill can be seen to the left.

average above 90 percent and the in-place strength varied from about 100 pounds per square foot at a depth of 10 feet to 400 to 500 pounds per square foot at a depth of 40 feet. Without any special treatment this soil will support fills of about 6 feet in height. With the use of struts it is possible to build somewhat higher fills.

The height of fill required to produce the planned profile grade at the west approach to the Napa River Bridge varied from less than five feet to over 50 feet above the mud flats. With normal construction the fill would end and the structure begin where the profile grade was about five feet above the mud flats. The cost of sand drain treatment and fill construction was estimated at about $120,000 per station less than a structure. The uses of special treatment of the foundation soil thus results in definite savings.

The new alignment was adjacent to the existing roadway, thus avoiding interference with existing traffic. The west approach fill could be constructed prior to the structure under a separate contract, allowing sufficient time to construct and observe the fill.

Frequently Used

Sand drains had been frequently used to stabilize the soft bay mud similar to the soft soils at the west approach to the Napa River Bridge, with questionable benefits being obtained. Only a slight increase in strength of the soft bay mud was observed at the previous locations during construction. Areas with sand drains consolidated at a slightly more rapid rate than areas without sand drains during construction. A large amount of new construction is planned on similar types of soft soil where special foundation treatment would be advantageous.

The soft bay mud was very impervious, having a permeability of 10^{-5} feet per hour. Theoretical calculations indicated that sand drains on an eight-foot spacing would consolidate the soil at a rate that would increase the strength sufficiently to allow a rate of loading of one and one-half feet of fill per week. In previous sand drain construction on similar soils a spacing of ten feet had been used with a rate of loading of three feet of fill per week. With fills above 15 feet in height

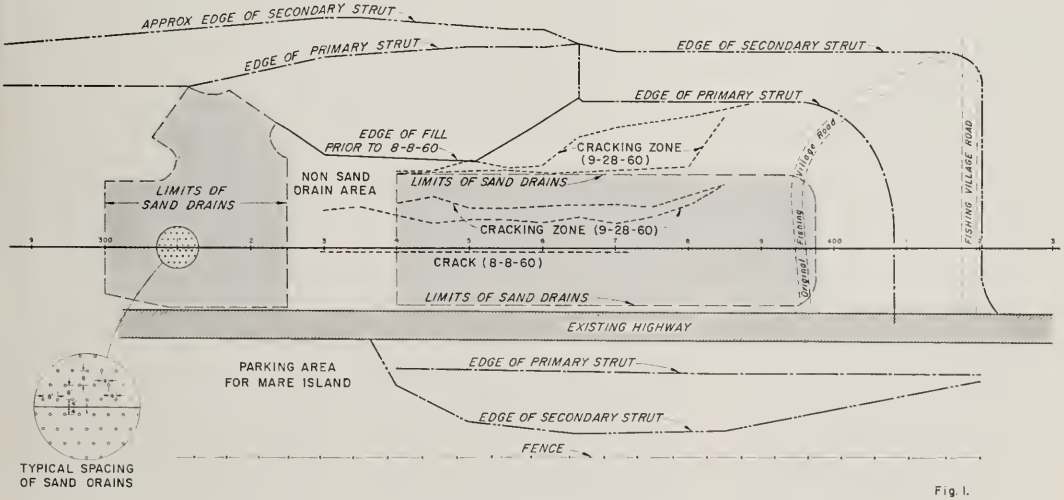


Fig. 1.

This map of the area shows the location of the sand drain areas in relation to the existing highway.

CROSS SECTION OF FILL SHOWING WIDENING OF STRUT FILLS

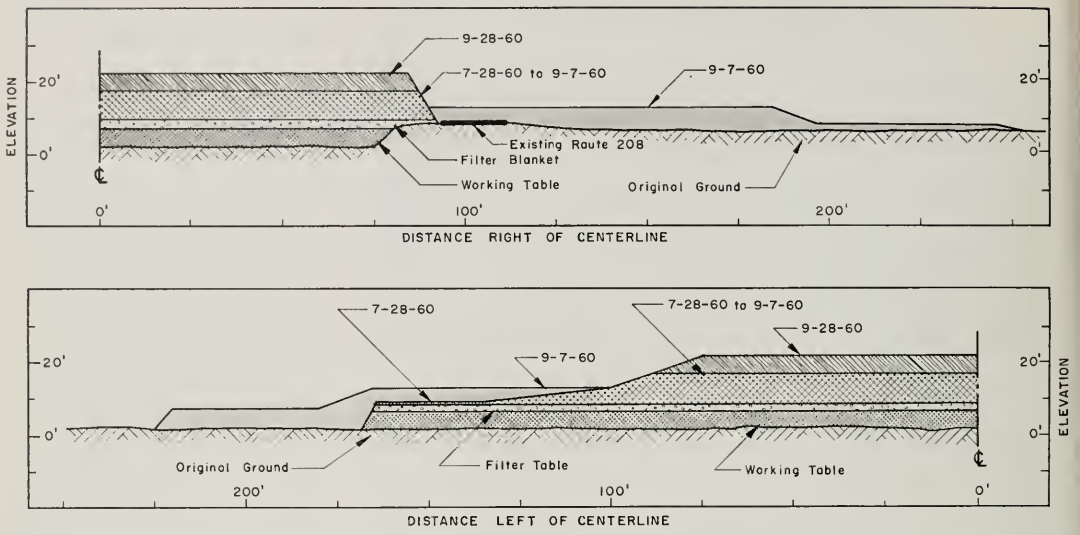


Fig 2.

berms 100 feet wide and eight feet high were planned on the left side of the fill and the existing roadway acted as a berm on the right side. Sand drains were installed under the main fill only.

Test Section

It was desired to conduct a test section to attempt to determine why sand drains have frequently not strengthened the foundation soil as anticipated. A comparison of areas with and without sand drains was desired to determine the amount that sand drains accelerate the consolidation of the foundation soil.

The following prerequisites were considered necessary for this experimental fill:

1. The test section should be part of a future construction.
2. Sufficient time should be available to construct the test fill and to have time to observe its behavior prior to completion of the project.
3. The height of required fill should vary from low enough to be stable without foundation treatment to high enough that it was questionable whether a stable fill could be constructed with sand drains.
4. The soil conditions should be sufficiently uniform so as not to present a variable.
5. The project should be in an area where construction would cause the minimum interference with traffic.
6. The site should be one where stabilization of the foundation soil would result in an economic savings.

The above conditions existed at the west approach to the Napa River on State Sign Route 48.

To accomplish the objectives of the test, the cross-section and profile were varied in increments as shown in Figures 1 and 2. Design details are shown on the drawings, and summarized in the accompanying table.

DESIGN DETAILS

Approximate station	*Elev. top of fill*	*Avg. Ht. of fill*	*Drainage features*	*Struts*
388+50–390+00	11.5	8′	None	no
390+00–391+25	11.5	10′	Sand drains under main fill and filter blanket	no
391+30–392+50	16.5	15′	Sand drains and filter blanket	no
392+50–394+00	16.5	15′	No drains; filter blanket	no
394+10–395+75	24.0	22.5′	Sand drains and filter blanket	yes
395+90–397+50	34.0	32.5′	Sand drains and filter blanket	yes
397+65–399+25	44.0	41.5′	Sand drains and filter blanket	yes

Construction

On February 11, 1960, the Attorney General approved the award of a contract to Fredrickson & Watson Construction Co. of Oakland for the construction of 1,200 feet of fill as a bridge approach on the west side of the Napa River.

This was an experimental project and was to be a step-type, surcharged design with struts 100 feet wide to be placed adjacent to the main portion of the fill on the left. The right edge was not to be strutted because of the existing traveled way of Route 208. After the desired height was reached, a waiting period would begin to allow the fill to stabilize itself.



This photo shows the failure of the left side of the moin fill which occurred on September 27, 1960.

A material site for the imported borrow was available east of the river and after scales were set up, trucks were weighed prior to crossing the existing Napa River Bridge and loads kept to within the legal limit.

The main portion of the fill was to have been stepped up from 11 to 44 feet in elevation and was placed at a controlled rate of 1½ feet per week after sand drains had been driven and a two-foot blanket of filter material placed.

Due to the extremely swampy nature of the original ground, a working platform of import was constructed over the tules and swamp grass. With the exception of a few large timbers, no clearing was performed. Some care was taken not to place large rocks in the working platform because of the anticipated difficulty in driving of sand drains through this part of the fill.

The platform was kept as thin as possible to obtain deeper penetration of the drains and to keep from creating a "mud" wave at the front edge of the fill. However, if the working platform was too thin, equipment broke through and overturned. If it was too thick, the "wave" in front became higher and higher until it became impossible to cover with import. At such times, the fill would be "split" and the bulge of mud surrounded with import. By working from the outside toward the center of the area, it was possible to construct the platform without increasing the size of the "wave." However, the platform had to be reinforced at several spots during pile driving operations despite the fact mats of 12″ x 12″ timbers were used.

Compressed Air Applied

Raymond Concrete Pile Company subcontracted the placing of the sand drains. Approximately 2,500 drains (154,500 l.f.) varying in depth from 42 to 72 feet were driven, using an 18-inch I.D. hollow mandrel with a hinged bottom. After the mandrel had been driven and the sand placed inside, compressed air was applied at the top, forcing the sand out of the bottom as the steel shell was withdrawn. It was found that if the sand was too wet, it would compact within the mandrel and not flow out until the bottom of the tube was above the platform. In such cases, the pile was redriven.

Some drains brought swamp gas to the surface which caught fire occasionally. This gas burned with such a colorless, odorless flame that it would go unnoticed until the timber mats began to smoke and blaze. A steam hose would then be used to put out the fire.

After the drains were completed, a two-foot blanket of filter material was

placed at the prescribed locations. To aid drainage of water from the filter blanket an 8-inch PMP was placed along centerline. Construction of the main portion of the fill was then started. Despite the controlled elevation, edge failures occurred from time to time and the outside strut was widened and increased in height. After placing sixteen feet of fill and an elevation of 17 feet was reached, cracks began to appear on the right side in the existing traveled way.

Traffic Is Detoured

Placing of fill was immediately suspended and a strut built on the right. Traffic was temporarily detoured to the right until additional fill could be placed on top of the existing pavement. After this fill was brought to an elevation of 14 feet, traffic was rerouted to the original pattern and the far right strut reinforced.

On September 27th, at an elevation of 22 feet, the left edge of the fill began to fail. Numerous cracks from two to seven feet in width and as much as sixteen feet in depth appeared. The strut on the left was widened and the height increased. A waiting period was begun.

On December 7th, it was decided to curtail all further operations until a later date. The top of the fill was dressed up and the cracks filled.

At the time, 329,300 tons of imported borrow and 54,000 tons of filter material were in place.

The contract was closed on January 15, 1961.

The present elevation of the fill in the vicinity of Station 396+00 is about 17. Fill will be placed in the near future to bring the fill surface to elevation 23 between Station 395+90 and 396+80. The fill will be placed at a rate of one foot per week. The structure will then begin at Station 396+00.

Considerable instrumentation was incorporated in the test section during construction to furnish observational data that would give a record of the behavior of the foundation soil during and after filling operations. The following instruments and devices were installed in the test section.

1. Settlement platforms
2. Heave stakes
3. Slope indicators
4. Piezometers.

Results of Studies

It had been anticipated that the 41-foot fill would be of marginal stability and the 32-foot fill completely stable. The failures of the fill at a height of 22 feet was rather startling. This failure was due to the drainage of water from the foundation soil occurring at a slower rate than had been anticipated.

Minor cracking appeared along centerline on August 8, 1960, that indicated a movement was occurring to the right of centerline. The existing roadway failed to give the support anticipated despite the fact that the foundation soil had consolidated and increased in strength under the existing roadway. Increasing the height and width of the roadway fill stabilized the right side.

The final failure on September 27, 1960, was principally movement to the left. This failure consisted of movement to a depth of about 20 feet below original ground. This was a very shallow type of movement. In the design it was felt that the 100-foot wide berm would force the failure to a greater depth where the strength of the soil was greater. This shallow failure indicated that very wide berms would have been required to support the fill. An alternative to such a wide berm would be the stabilization of the foundation soil under the berm by means of sand drains.

Faster Rate

Figure No. 3 shows the centerline settlement profile. The settlement in the sand drain areas occurred at a faster rate than in the non-sand drain areas. The piezometric pressures indi-

PROFILE ALONG ℄ OF ROAD X-SOL-208-A, WEST APPROACH TO NAPA RIVER
SHOWING
SETTLEMENT OF GROUND IN SAND DRAIN AREAS & NON SAND DRAIN AREAS AS FILL WAS PLACED

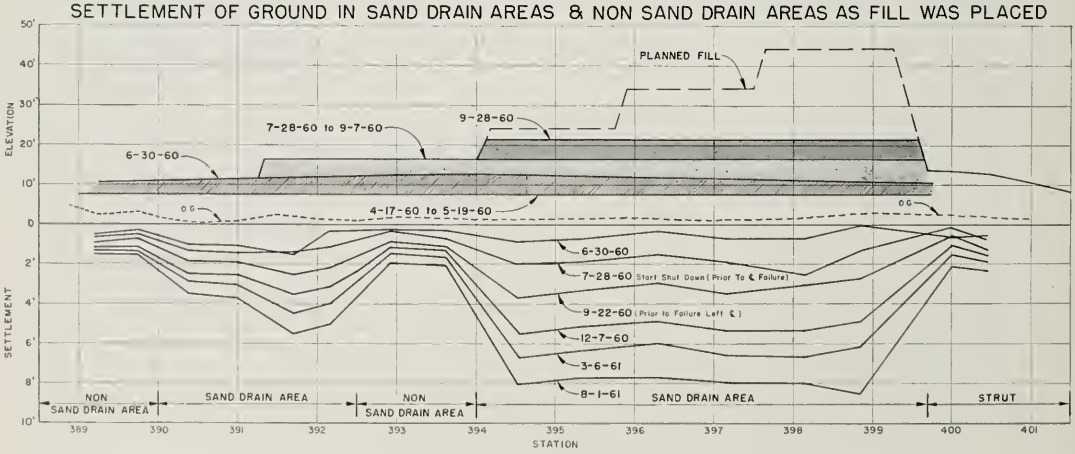


Fig. 3.

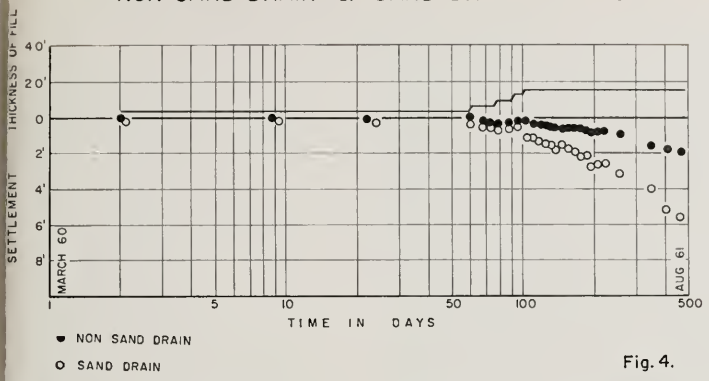


Fig. 4.

cated a very small consolidation occurred in the non-sand drain areas; the consolidation in the sand drain areas was about four times greater. This all indicates that sand drains did increase the rate of consolidation (See Figure No. 4). However, the rate of consolidation of the soft bay mud in the sand drain areas was about one-third the rate that was indicated by the theoretical studies. This slower rate of consolidation may have been due to such items as well resistance, periferial smear, remolding, etc. No attempts were made to study these items in this test section.

The data indicate that on future sand drain design studies on projects to be constructed on soft bay mud, with construction methods the same as at the test section, the rate of consolidation used will have to be considerably smaller than the estimated theoretical rate of consolidation. This should increase the dependability of design calculation for future sand drain projects.

The effect of the berm was somewhat different than had been estimated. It was expected that the existing roadway on the right would provide adequate strength to support the planned fills; however, it failed to do this. After the width and height of the roadway fill was doubled stability on the right was achieved. On the left side a width of berm of 100 feet was planned. This berm was widened to about 160 feet, including a secondary berm used to support the height of fill in the primary berm. The need of such wide berms had not been previously expected.

The end of the bridge would be at Section 391+50 without special foundation soil treatment. With the utilization of the fill constructed under this contract the structure will begin at Station 396+00, shortening the structure about 450 feet. The resulting savings will be in excess of $600,000 by using the fill instead of a structure.

Conclusions

This experimental sand drain project produced several items of information of benefit to the design and construction of future sand drain projects.

1. The consolidation of the foundation soil in sand drain areas will occur at a slower rate than estimated from theoretical studies.
2. Sufficient time must be available to construct fills on soft soils at a slow rate. It may be necessary to construct fills on soft soils under separate contracts and utilize stage construction.
3. Wider struts will be required than had generally been used in the past.
4. With the slow rate of consolidation of the foundation soil sand drains may be required under struts as well as under the main fill.

Marion Bradshaw Retirement Marked

Marion Bradshaw, hearing reporter for the State Department of Public Works, has retired after more than 20 years of state service.

Mrs. Bradshaw came to work for the Division of Contracts and Rights of Way, State Department of Public Works, in the capacity of senior legal stenographer in February, 1940.

She was certified to the position of hearing reporter in November, 1943, and has reported the Commission meetings since 1944. She also reported the California Toll Bridge Authority meetings.

Mrs. Bradshaw also organized the law library for the department.

Born in Grand Junction, Colorado, she was graduated from high school in Goldfield, Nevada, and attended college at Reno.

She is a member of the National Shorthand Reporters Association.

Albert McCarton

Albert P. McCarton, who retired in 1950 as Chief Draftsman and Safety Engineer in District IX of the Division of Highways, died August 31, 1961, in Yucaipa. He was 81 years old.

McCarton was born in Klamath Falls, Oregon, and came to California when he was five years old.

He began his engineering career in 1902 and worked on projects in Arizona, New Mexico, Colorado and California. He held his first job with the State in 1915 in Dunsmuir, but left in 1916 to be resident engineer for the Pacific Power Co. on the construction of three dams at Huntington Lake. He worked for the State from 1919 to 1921, and again from 1933 until his retirement.

McCarton, at the age of 17, served in the Spanish-American War; in World War I he was a lieutenant with the 23rd Engineers.

He is survived by his wife.

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Richmond-San Rafael Bridge Is 5 Years Old

The Richmond-San Rafael Bridge over San Francisco Bay was five years old on September 1, and the anniversary will mark the close of the most successful year for the state-owned toll facility.

Steadily increasing traffic on the bridge in the past year continued to produce sufficient toll revenue to pay all bond interest and operating expense.

State Highway Engineer J. C. Womack said the bridge is now "a definite financial success and an important asset to state highway users."

Construction of the $66,000,000 span by the State Division of San Francisco Bay Toll Crossings began February 26, 1953, after the California Toll Bridge Authority in December, 1952, authorized the sale of revenue bonds to finance the project.



Replaced Ferry

The upper deck was opened to traffic September 1, 1956, and the lower deck was placed in operation August 20, 1957. The bridge replaced a privately operated ferry service.

Since the bridge was opened, there has been a steady upward trend in traffic figures and toll revenue. Traffic has been increasing at a rate of about 10 per cent a year, and toll collections have been up about seven per cent annually.

In the first year of operation (September 1956-September 1957), the bridge carried 2,588,000 vehicles as compared to 3,519,000 in the past 12 months. Average daily traffic has climbed from 7,100 in 1956-57 to 9,400 in 1960-61.

Total Revenue

A total of 15,068,000 vehicles passed through the toll gates during the first five years. Toll revenue for the five-year period was approximately $12,-700,000.

Bridge toll collectors had their busiest day on Sunday, September 2, 1956, when 18,743 vehicles used the then brand new structure. The highest single-day traffic total in the past 12 months was 16,464 vehicles on Easter Sunday, April 2, 1961.

The bridge carries State Sign Route 17, providing a connection between U.S. Highway 40 in Richmond and U.S. 101 in Marin County.

It is one of the world's largest bridges. Total length of the bridge and approaches is five and one-half miles. The bridge structure itself is slightly more than four miles long. Roadways on both decks are 36 feet wide, providing three westbound lanes on the upper deck and three lanes for eastbound vehicles on the lower level.

185-Foot Clearance

The two main spans, both cantilever type, are 1,000 feet long. Clearance above the main channel is 185 feet at mean high water, 135 feet above the secondary channel. The deepest piers extend 222 feet below the surface of the bay. The highest towers are 325 feet above the water.

Toll rates for the bridge range from 75 cents for passenger cars and similar vehicles to four dollars for a seven-axle truck.

The bridge is operated and maintained by the Division of Highways and has a full-time staff of 75 persons including 18 toll collectors and 35 painters, as well as emergency road service crews, electricians, and supervisory personnel.

As is the case with other San Francisco Bay bridges, the Richmond-San Rafael Bridge requires constant painting to protect it from the elements. It will be another two to five years before paint crews finish painting the entire structure for the first time.

California Highways and Public Works
DIVISION OF HIGHWAYS
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The infinite variety of California's landscape is suggested in these two highway scenes photographed by Robert Dunn. The front cover shows a section of the Harbor Freeway in Los Angeles, with its many crossings and ramps serving the downtown area (see "L.A. Renaissance," beginning on page 29). The highway on the back cover is a portion of U.S. 101, the Redwood Highway, newly widened and realigned on a freeway basis, alongside Outlet Creek between Willits and Laytonville in Mendocino County.



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ANNUAL REPORT ISSUE

Letters of Transmittal

December 7, 1961

Edmund G. Brown
Governor of California

My Dear Governor:

I am pleased to submit the 15th Annual Report of the Division of Highways, Department of Public Works. The report presents an overall view of the California highway program for the 1960-61 Fiscal Year, and outlines the tremendous highway improvements which are being made.

Highway transportation will continue for many years to be our principal means of moving people and goods, even though other methods of mass transportation may be introduced or improved. Motor vehicle travel in this State will triple in the next 20 years.

Facing this prospect, we are building highways designed to assure present and future mobility in a dynamic California society.

The highway construction program has been accelerated to record levels during the past year. New sections of freeway or improved highway are being opened nearly every week. In the past three years we have increased the total freeway mileage in California by some 300 miles, yielding large dividends of safety and convenience for the State's motorists.

While the construction program moves ahead, advances are also being made on the planning front. Co-operation between the State and local communities is being emphasized, particularly in regard to freeway planning. During the past 12 months, the California Highway Commission has adopted routes for 435 miles of freeway, increasing the statewide mileage total for adopted routes to 5,825.

This is a significant accomplishment in view of the many complex problems involved in almost every route selection.

With construction proceeding according to established long-range plans, and the emphasis on fiscal continuity in budgeting, the extensive program of highway development in this State continues as an impressive example of your administration's sustained and orderly progress in meeting the needs of growing population in California.

Respectfully,

Robert B. Bradford

ROBERT B. BRADFORD
Director of Public Works

December 7, 1961

Robert B. Bradford
Director of Public Works
State of California

Dear Sir:

Submitted herewith for your approval and transmittal to Governor Edmund G. Brown is the Fifteenth Annual Report of the Division of Highways. The report is prepared in compliance with Section 143 of the Streets and Highways Code and generally covers the fiscal year ending June 30, 1961, although some later information on the construction program is included.

Progress in freeway planning and construction, particularly on routes included in the National System of Interstate Highways, continues as the salient feature of the state highway program. More than 100 miles of new freeway have been opened in the past year. Construction is now in progress on an additional 400 miles.

The national target date for completion of the Interstate System is 1972. California must continue to place great emphasis on interstate construction if the State's 2,200 miles of interstate routes are to be completed on time.

At present, work has been completed on 642 miles of interstate highway and construction is underway or budgeted on another 317 miles. About one-third of the completed mileage is developed to ultimate interstate standards, while the remainder is considered adequate for present traffic requirements. Freeway routes have been adopted for about 85 percent of the interstate highway in California.

Continuing the practice started last year, the text portion of the annual report is again included in our bimonthly magazine, *California Highways and Public Works*. Financial statements, apportionment tables and contract statistics will be published in a supplement which will be available to interested persons.

J. C. Womack

J. C. WOMACK
State Highwoy Engineer

California Highways and Public Works

Official Journal of the Division of Highways, Department of Public Works, State of California

Vol. 40 November-December 1961 Nos. 11-12



FRONT COVER—Set against a backdrop of evergreen forests and the snow-covered slopes of Mount Shasta, this new section of Interstate highway now speeds motorists along U.S. 99 south of Dunsmuir, Siskiyou County. The paved section at far right is part of a vista area where travelers may safely park and enjoy a spectacular view of the 14,162-foot peak.—Color photo by Jack Meyerpeter

BACK COVER—Heavy grading was under way when photographer Bob Dunn snapped this color picture of freeway construction on U.S. Highway 40 (Interstate 80) on the Rindler Fill section just east of Vallejo. This project is one of a series of major freeway jobs now in progress or budgeted on this important cross-state route. Note the old four-lane undivided highway (left) which will be eliminated when the new freeway is opened to traffic.



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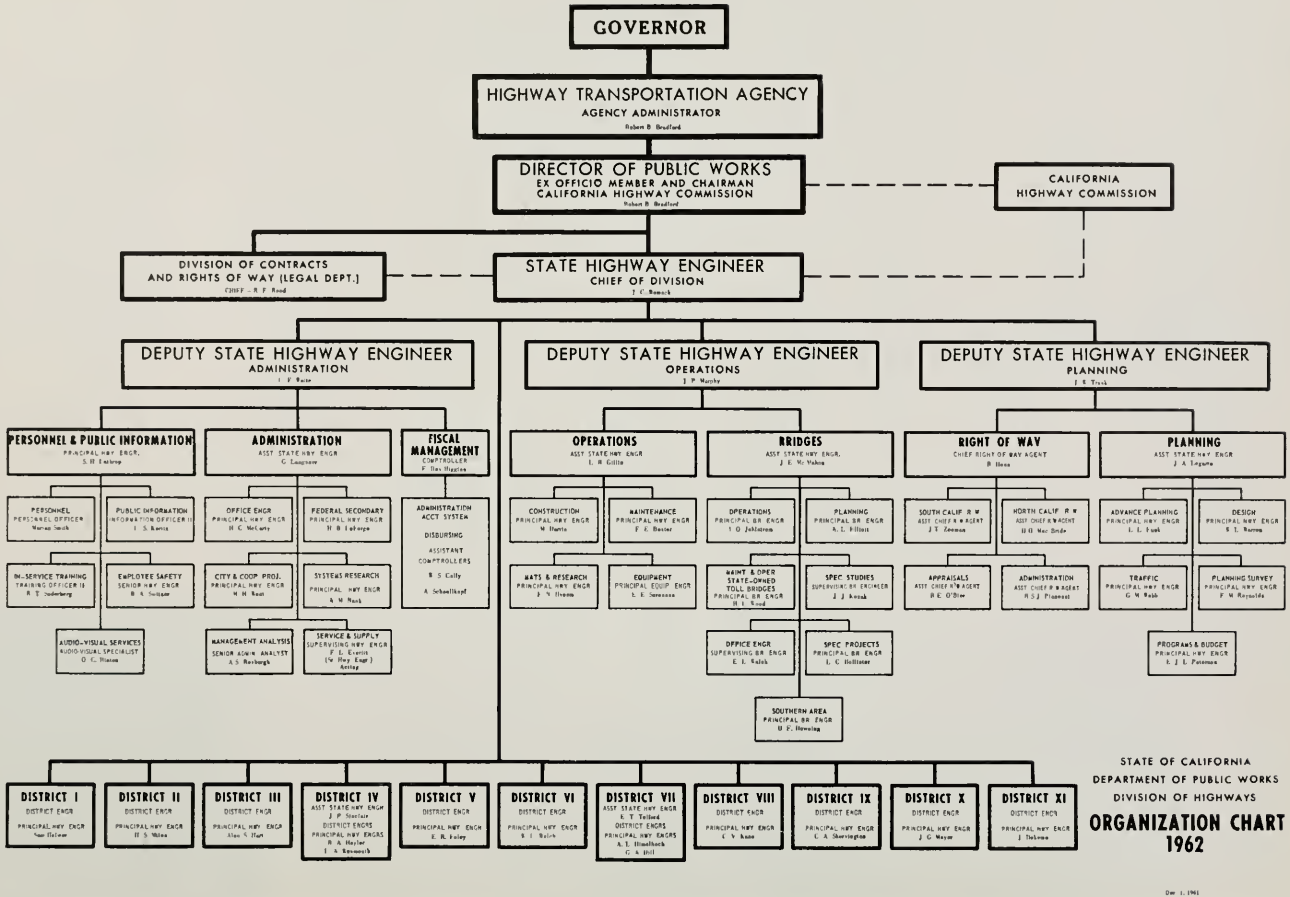
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Address communications to: EDITOR,

CALIFORNIA HIGHWAYS AND PUBLIC WORKS

P. O. Box 1499

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DISTRICT XI
DISTRICT ENGR.
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DEPARTMENT OF PUBLIC WORKS
DIVISION OF HIGHWAYS
ORGANIZATION CHART
1962
Dec 1, 1961

STATE OF CALIFORNIA

DEPARTMENT OF PUBLIC WORKS

CALIFORNIA HIGHWAY COMMISSION

ROBERT B. BRADFORD, *Chairman, Ex Officio*

Member	*Residence*	*Date of original appointment*	*Term expires*
JAMES A. GUTHRIE	San Bernardino	September 14, 1943	January 15, 1965
ROBERT E. MCCLURE	Santa Monica	January 18, 1954	January 15, 1962
ARTHUR T. LUDDY	Sacramento	February 16, 1959	January 15, 1963
ROGER S. WOOLLEY	San Diego	March 18, 1959	January 15, 1963
JOHN ERRECA	Los Banos	January 15, 1961	January 15, 1965
ABRAHAM KOFMAN	San Jose	September 14, 1961	January 15, 1964

Secretary: A. J. COOPER

Assistant Secretary: GEORGE N. COOK

CALENDAR OF MEETINGS

CALIFORNIA HIGHWAY COMMISSION

July 1, 1960 to June 30, 1961

* July 19, 1960 — Los Angeles

* July 20, 1960 — San Diego

* August 31, September 1 and 2, 1960 — Sacramento

* September 27 and 28, 1960 — Sacramento

October 11, 1960 — Hayward
(Special session to vote $750,000 to road VII-LA-167-LA, from at or near Botschke Slough to Terminal Island.)

October 18, 1960 — Chino
Special session for inspection of roads VII,VIII-LA,SBd, Riv.-19-Pom;A,Chn,Ont,B;A and VII-LA-161-LA,Gndl.)

* October 25, 1960 — Sacramento

October 27, 1960 — Los Angeles
(Public hearing on freeway location, road VII-LA-161-LA, Gndl, between Route 4 and Figueroa Street.)

October 28, 1960 — Chino
(Public hearing on freeway location, road VII,VIII-L.A,SBd, Riv-19-Pom;A,Chn,Ont,B;A, between State Sign Route 71 and one mile east of the Mira Loma Grade Separation.)

* November 22, 1960 — Sacramento

* December 14, 1960 — Sacramento

* January 25, 1961 — Sacramento

* January 26, 1961 — San Francisco

January 27, 1961 — San Jose
(Public hearing on freeway location, road IV-SCl-2-C,Gil, MgH,B,SJs, between 0.4 mile south of Thomas Road and Route 68 near Ford Road.)

* February 23 and 24, 1961 — Sacramento

* March 22, 1961 — Los Angeles

March 23, 1961 — San Bernardino
(Special session for inspection of roads in Riverside and San Bernardino Counties.)

* April 13, 1961 — Sacramento

April 14, 1961 — Hayward
(Public hearing on freeway location, road IV-Ala-5-D,Hay, C,UnC,Fmt, between Route 228 and Washington Boulevard in the Irvington District of Fremont.)

May 2, 1961 — Daly City
(Public hearing on freeway location, road IV-SM-56-D1C,F, State Highway Route 56 (State Sign Route 1) in San Mateo County between Skyline Boulevard and Junipero Serra Freeway.)

* May 24 and 25, 1961 — Sacramento

* June 21 and 22, 1961 — Sacramento

* Regular meetings.

PAST MEMBERS OF THE CALIFORNIA HIGHWAY COMMISSION

Name	Residence	Date of appointment	Termination of membership
Burton A. Towne*	Lodi	Aug. 2, 1911	Resigned Jan. 14, 191
Charles D. Blaney*	Saratoga	Aug. 2, 1911	Resigned Mar. 1, 191
N. D. Darlington*	Los Angeles	Aug. 2, 1911	Resigned Jan. 8, 192
Charles F. Stern	Eureka	Jan. 15, 1914	Resigned Dec. 21, 191
Henry J. Widenmann*	Vallejo	Mar. 1, 1917	Died Oct. 6, 191
Charles A. Whitmore*	Visalia	Nov. 29, 1918	Resigned Jan. 8, 192
Emmett Phillips*	Sacramento	Dec. 21, 1918	Died June 18, 191
George C. Mansfield*	Oroville	June 24, 1919	Resigned Jan. 9, 192
Harvey M. Toy*	San Francisco	Jan. 9, 1923	Resigned Jan. 3, 192
Louis Everding*	Arcata	Jan. 9, 1923	Resigned Jan. 17, 192
Nelson T. Edwards*	Orange	Jan. 10, 1923	Resigned Jan. 3, 192
Ralph W. Bull*	Eureka	Jan. 6, 1927	Resigned Jan. 6, 193
J. P. Baumgartner*	Santa Ana	Jan. 6, 1927	Resigned Jan. 6, 193
M. B. Harris*	Fresno	April 18, 1927	Resigned Jan. 6, 193
Joseph N. Schenck*	Los Angeles	Aug. 19, 1927	Resigned Jan. 6, 193
Fred S. Moody*	San Francisco	Aug. 19, 1927	Resigned Jan. 6, 193
Earl Lee Kelly	Redding	Jan. 6, 1931	Resigned Oct. 18, 193
Frank A. Tetley*	Riverside	Jan. 6, 1931	Resigned July 31, 193
Timothy A. Reardon*	San Francisco	Jan. 6, 1931	Resigned May 7, 193
Harry A. Hopkins*	Taft	Jan. 6, 1931	Resigned Oct. 14, 193
Philip A. Stanton*	Anaheim	Jan. 6, 1931	Resigned Mar. 3, 193
Dr. W. W. Barham	Yreka	Dec. 20, 1932	Resigned May 21, 193
Ray Ingels	Ukiah	May 21, 1935	Resigned Oct. 4, 193
C. D. Hamilton*	Banning	Aug. 1, 1935	Died April 24, 193
H. R. Judah*	Santa Cruz	May 7, 1936	Resigned Oct. 5, 193
Paul G. Jasper*	Fortuna	May 7, 1936	Resigned Mar. 3, 193
William T. Hart*	Carlsbad	July 7, 1936	Resigned Mar. 3, 193
Robert S. Redington	Los Angeles	Oct. 5, 1937	Resigned Jan. 27, 193
Frank W. Clark	Los Angeles	Jan. 27, 1939	Resigned Mar. 10, 193
Lawrence Barrett	San Francisco	Mar. 3, 1939	Resigned Jan. 11, 194
Iener W. Nielsen	Fresno	Mar. 3, 1939	Resigned Jan. 11, 194
Amerigo Bozzani	Los Angeles	Mar. 3, 1939	Resigned Jan. 11, 194
Bert L. Vaughn	Jacumba	Mar. 3, 1939	Resigned Jan. 11, 194
L. G. Hitchcock	Santa Rosa	Mar. 10, 1939	Resigned Jan. 11, 194
Gordon H. Garland†	Sacramento	Jan. 11, 1943	Resigned Sept. 14, 194
Mrs. Dora Shaw Heffner†	Sacramento	Jan. 11, 1943	Resigned Sept. 14, 194
Miss Helen MacGregor†	Sacramento	Jan. 11, 1943	Resigned Sept. 14, 194
Verne Scoggins†	Sacramento	Jan. 11, 1943	Resigned Sept. 14, 194
William Sweigert†	Sacramento	Jan. 11, 1943	Resigned Sept. 14, 194
C. Arnholt Smith	San Diego	Sept. 14, 1943	Resigned Jan. 1, 194
C. H. Purcell*	Sacramento	Sept. 14, 1943	Resigned July 31, 195
Homer P. Brown*	Placerville	Sept. 14, 1943	Resigned Oct. 26, 195
Harrison R. Baker	Pasadena	Sept. 14, 1943	Jan. 15, 1954
Charles T. Leigh	San Diego	May 11, 1949	Jan. 15, 1955
F. Walter Sandelin	Ukiah	Sept. 14, 1943	Jan. 15, 1956
Frank B. Durkee	Sacramento	Aug. 4, 1951	Resigned Dec. 31, 195
H. Stephen Chase	San Francisco	Oct. 30, 1951	Resigned Feb. 25, 195
Fred A. Speers	Escondido	Jan. 21, 1955	Jan. 15, 1959
C. M. Gilliss	Sacramento	Jan. 1, 1958	Resigned Nov. 10, 195
John O. Bronson	Sacramento	Feb. 26, 1958	Jan. 15, 1959
T. Fred Bagshaw	Mill Valley	Nov. 10, 1958	Resigned Jan. 4, 195
Robert L. Bishop	Santa Rosa	Jan. 15, 1956	Jan. 15, 1960
Chester H. Warlow	Fresno	Sept. 14, 1943	Jan. 15, 1961
John J. Purchio	Hayward	Jan. 15, 1960	Resigned Sept. 9, 196

* Deceased.
† Member of the Interim Commission.

California Highways....1961

California's growth and development in the second half of the 20th Century is dependent on sound planning and mobility.

Since World War II the State has been coping vigorously with the need for construction of major public facilities of all types—to conserve and develop its resources, to meet the immediate needs of its continuously expanding population and to plan and build for the future.

With Californians now driving nearly 9,000,000 motor vehicles, about one for every two residents of the State, and with these vehicles covering a total of more than 70 billion miles in 1961, the State's need for modern highway facilities is a prime example of the problems and challenge which accompany rapid growth.

California's program of pay-as-you-go highway modernization was stepped up in 1947 and further accelerated in 1953 with additional financing and again in 1956 through the Federal Aid Highway Act.

In 1947, there were about 480 miles of multi-lane divided highway mileage on the State Highway System. There are now 2,360 miles in operation, most of it of the freeway or expressway type, with the built-in permanence of traffic capacity assured by control of access.

There are still critical deficiencies on state highways, although the worst of them are being remedied as funds permit. There is serious congestion at peak traffic hours on some partly completed metropolitan freeway systems.

But on the whole, traffic is generally moving better and more safely than it was in 1947, even though the number of cars and trucks has more than doubled.

And the new freeways are being designed and built so that when the traffic volume doubles again—as it is expected to do within two decades—it will still flow smoothly and safely, even at the staggering estimated total movement of 200 billion miles a year.



This recently completed section of Santa Monica Freeway viaduct will be part of the 29-mile "loop bypass" which will skirt downtown Los Angeles and provide relief from traffic pressure on other central district freeways. The Los Angeles River Bridge and the East Los Angeles Interchange are at upper left.

Long-Range Planning

Because of a sound legislative and financing structure, a solid record of highway construction accomplishment and experience in long-range planning, California will be prepared to handle the anticipated increases in its population and traffic.

A master plan for the State's freeway and expressway system emerged from engineering and economic studies in 1957 and 1958 and was adopted by the State Legislature in 1959.

This plan, the "California Freeway-Expressway System," calls for $10.5 billion in freeway and expressway construction over a 20-year period. It includes 12,500 miles of the overall 16,000-mile State Highway System.

In 1980, the system will connect all cities of 5,000 or more persons, carry 59 percent of the total motor vehicle travel, and serve every major industrial, agricultural and recreation region.

For the big metropolitan areas, the plan envisions strategically located freeways and expressways which will function in combination as a system, providing maximum highway capacity between main points of traffic origin and destination.

Routes in the freeway-expressway system, like other state highways, have been designated by the Legislature in a general way. In most cases, only the termini have been specified.

WOMACK SERVES AS AASHO PRESIDENT

State Highway Engineer J. C. Womack, Chief of the California Division of Highways, has been named president of the American Association of State Highway Officials for 1962.

Womack was elected to head the national association at its annual meeting held in October at Denver, Colorado.

He has previously served as first vice president of the organization and has presided over several AASHO committees. He has also been a member of numerous committees over the years, mainly in the field of design policy and liaison with contractor groups.

He was appointed to the State Highway Engineer position in December 1959. He joined the Division of Highways staff in 1929. For the past 15 years, and especially since his appointment as Planning Engineer in 1948, he has been closely identified with the State's long-range program of highway improvement.

These general legislative descriptions provide the guidelines for detailed studies and public discussions leading to the adoption of the specific routes and to decisions on design matters.

The master plan takes advantage of the orderly progress and careful advance planning of the past. Specific routes have already been established for nearly half of the total freeway-expressway system mileage, including freeways and expressways now constructed and in operation.

Access Control

Throughout the world, highway engineers and planners have now adopted the access control principle in designing high-capacity highways. California helped pioneer the access control concept. Its basic freeway law was enacted in 1939.

Although the State Highway System includes hundreds of miles of conventional highway, the emphasis in recent years has been on two types of modern highway with access control—full freeways, and expressways.

Under California law, both types are "freeways"; that is highways with a varying degree of access control. To the motorist, however, these highways are entirely different in appearance.



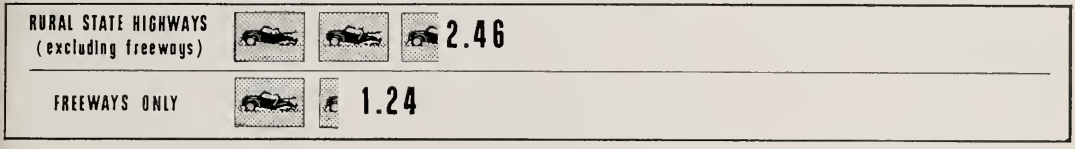
Median barriers are being installed to prevent cross-median headon collisions on heavily traveled freeways such as this section of the Nimitz Freeway in Oakland. Shown here is the fence-cable barrier developed by the Division of Highways in a series of crash tests.

FATALITY RATE PER 100 MILLION VEHICLE MILES

(1956-1960 AVERAGES)



ACCIDENT RATE PER MILLION VEHICLE MILES



A *full freeway* is a divided highway with from four to eight lanes. Access is restricted to locations where traffic may enter and leave the highway safely. There are no left turn movements in front of oncoming cars on freeways, and intersecting roads cross over or under the highway by means of separation structures. There are 922 miles of full freeway in operation in the State and another 397 miles under construction.

An *expressway* is a four-lane divided highway with most of the features of a full freeway, except that cross traffic and sometimes private access may be permitted at some locations. Most expressways are designed for eventual conversion to full freeway standards. California now has 900 miles of four-lane expressway in operation or under construction.

California also builds *two-lane expressways*, usually in rural or mountain areas where the present traffic load is relatively small. These highways are much like ordinary two-lane facilities, but access is planned to eliminate potential hazard and congestion. Enough right of way is initially required to permit future upgrading to four-lane expressway.

Why Build Freeways?

Freeways are now planned, under construction or in operation in most parts of the world where the automobile is a primary method of transportation.

There is good reason for this. Modern freeways carry more traffic in greater safety than any other type of highway.

A freeway is the engineer's answer to the challenge of today's massive traffic volumes. One freeway lane has three times the traffic capacity of a normal city street lane.

The tremendous efficiency of freeways in handling heavy traffic is evident in Los Angeles where some portions of the partly completed metropolitan freeway system are now carrying more than 200,000 vehicles a day.

A more significant freeway benefit, however, is safety. California's freeways for many years have had a better safety record than all other types of highways in the State.

For the past five years, the fatality rate on freeways has been about one-third the rate on conventional rural highways, and the overall accident rate has been about one-half the conventional highway rate. (*See accompanying chart.*)

Freeways promote safety for foot traffic, too. Pedestrians and bicycles are not permitted on freeways, and crossing structures and fencing prevent children from darting into the path of fast-moving vehicles.

From the long range viewpoint, freeways are a real "blue chip" investment. The capacity and safety benefits of freeways are permanent. Freeways built 20 years ago in this State still are capable of handling the



US Highway 101 is rapidly being converted to freeway and expressway standards. This new freeway bypass at Greenfield, Monterey County, is typical of the tremendous improvements which are being made.

large traffic volumes for which they were originally designed, in contrast with the old style boulevards which quickly became choked with traffic due to roadside strip development and unrestricted access.

It costs motorists less to operate their cars on a freeway. Studies have shown a saving of more than a half-cent a mile on freeways, as compared to ordinary streets, in gasoline and upkeep alone. There are also great savings resulting from travel time reductions and reduced accident exposure.

Community Benefits

Experience shows that properly located freeways help local business by removing traffic from overburdened streets, thus easing business district congestion for the local people who do most of the buying.

At the same time, freeway connections and interchanges, marked by large directional signs, make it easier to get to the business district.

Records of real estate transactions show that practically all commercial property along or near a freeway increases in value after the freeway is completed. This strengthens the local tax base and usually more than offsets the value of the land used for the freeway itself.

After a freeway is built through a community, residents frequently discover that they may once again drive from one side of town to the other without encountering frustrating delays due to traffic congestion. They find that the freeway crossing structures have reunited the community which was formerly split in two by a moving barrier of heavy traffic.

With a freeway in operation, traffic noise and fumes generated by stop and go traffic on city streets are reduced because there are no stop signals on a freeway and traffic moves along smoothly.

In short, freeways save time, lives and money, provide a wide range of community benefits, and preserve the mobility which is so much a part of the California way of life and a necessity in the State's growth.

The Highway Organization

California legislators have enacted the laws and established the policies which provide the basic legal and policy framework for the highway program.

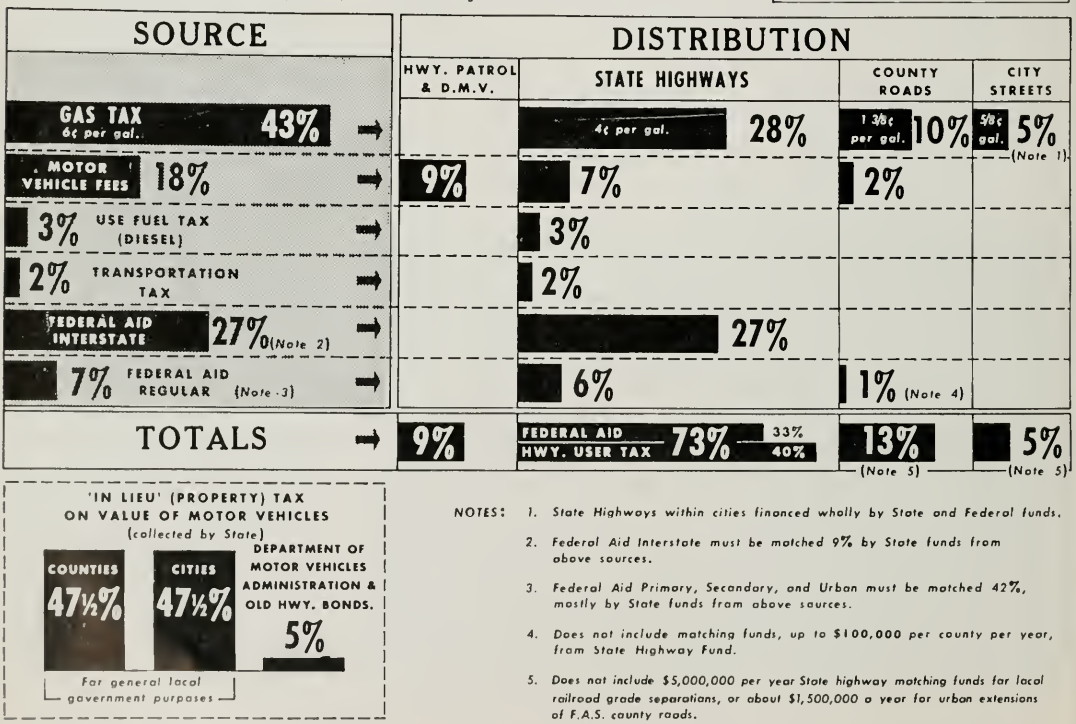
While maintaining a keen interest in highway matters, both local and statewide, the legislators have delegated to the California Highway Commission the authority and responsibility for determining highway routes and allocating construction funds.

This long-standing legislative policy has assured the continuity of the high-

Highway User Taxes Including Federal Aid

Percentages based generally on 1962-63 Budget.

State of California
Department of Public Works
Division of Highways



'IN LIEU' (PROPERTY) TAX ON VALUE OF MOTOR VEHICLES (collected by State)

NOTES:

1. State Highways within cities financed wholly by State and Federal funds.
2. Federal Aid Interstate must be matched 9% by State funds from above sources.
3. Federal Aid Primary, Secondary, and Urban must be matched 42%, mostly by State funds from above sources.
4. Does not include matching funds, up to $100,000 per county per year, from State Highway Fund.
5. Does not include $5,000,000 per year State highway matching funds for local railroad grade separations, or about $1,500,000 a year for urban extensions of F.A.S. county roads.

way program over the years, fostering the steady progress which has characterized California highway development.

The effect of these policies has been to free the highway organization from the pressures of partisan politics and sectionalism, permitting highway planning to proceed on the basis of statewide need and benefit. As a result, our highways are safer, more efficient, and designed to provide the greatest good for the greatest number of Californians.

California Highway Commission

The California Highway Commission is a nontechnical board of business and professional men. Commissioners are appointed by the Governor with confirmation by the State Senate.

The State Director of Public Works is commission chairman. The other members serve without pay for four-year staggered terms. Commissioners represent the entire State, not a specific city or area.

In addition to budgeting highway funds and adopting freeway and highway routes, the commission also approves county primary road systems and authorizes condemnation proceedings, the execution of deeds, and right-of-way relinquishments and abandonments.

Division of Highways

The State Division of Highways, a unit of the Department of Public Works, handles the day-to-day administration of the highway program, operating according to the requirements of state law and policies of the Highway Commission.

The division is in charge of all state highway planning, design, right-of-way acquisition, construction and maintenance. Its activities cover the entire range of highway work from large scale freeway and bridge construction to small but essential maintenance jobs.

Chief of the division is the State Highway Engineer. He is assisted by a headquarters staff in Sacramento. As shown on the accompanying map, the State is divided into 11 state highway districts to provide for localized administration of the highway program. The engineer in charge in each district is responsible for all phases of the highway program in his region. (An organization chart is included on page 2.)



All of the engineers, maintenance crews, technicians, statisticians and others who work for the Division of Highways are state-paid civil servants. They are dedicated to serving the entire State, and their only goal is to provide the best possible value in safe and efficient highways for the taxpayer's dollar.

Information about local highway matters may best be obtained at the various district offices as follows:

District I—Sam Helwer, District Engineer
430 West Wabash Avenue
Eureka

District II—H. S. Miles, District Engineer
1657 Riverside Drive
Redding

District III—Alan S. Hart, District Engineer
703 B Street
Marysville

District IV—J. P. Sinclair, Assistant State Highway Engineer
150 Oak Street
San Francisco

District V—E. R. Foley, District Engineer
50 Higuera Street
San Luis Obispo

District VI—W. L. Welch, District Engineer
1352 West Olive Avenue
Fresno

District VII—E. T. Telford, Assistant State Highway Engineer
120 South Spring Street
Los Angeles

District VIII—C. V. Kane, District Engineer
247 Third Street
San Bernardino

District IX—C. A. Shervington, District Engineer
South Main Street
Bishop

District X—J. G. Meyer, District Engineer
1976 East Charter Way
Stockton

District XI—J. Dekema, District Engineer
4075 Taylor Street
San Diego

Highway Financing

The mainstay of California's highway financing is the state gasoline tax of 6 cents a gallon. Four cents is applied to state highways, 1⅜ cents goes for county roads, and ⅛ of a cent for city streets other than state highways.

In addition to the gasoline tax, other sources of highway revenue are use (diesel) fuel taxes, transportation taxes, and motor vehicle registration and weight fees. (Revenue sources and distribution for road purposes are shown on the chart on page 8.)

About one-third of the total highway revenue in California comes from federal sources for expenditure on various federal-aid highway systems of secondary, primary, urban and especially the interstate highways.

The 1960-61 State Highway Budget contained an overall total of $569,244,000 of which $452,785,000 was for state highway construction purposes including rights-of-way. The corresponding totals for the current 1961-62 budget are $633,460,000 and $509,078,000. As adopted by the Highway Commission in October, 1961, the record 1962-63 budget provides a gross total of $658,370,017 of which $527,792,917 is for state highway construction. (See article on 1962-63 budget on page 72.)

According to law, 55 percent of the money available each year for state highway construction and rights-of-way is allocated to the 13 southern counties. The remaining 45 percent goes to the northern 45-county group.

Each county is guaranteed a minimum share of the state highway construction funds in a specified period of years according to statutory formula.

In drawing up the annual state highway budget, Highway Commissioners must review hundreds of high-priority projects and attempt to choose those which will meet the most critical local and regional needs, comply with federal requirements, and fit logically into the long-range statewide program.

Careful attention is paid to the requests made by various highway-user groups, public service organizations, and individuals. Thorough study and comparison of all available data, including comprehensive information on traffic volumes, accidents, population changes, road conditions and other factors, is required.

Despite the tremendous number of projects which are financed each year, it is never possible to do everything that should be done in any given year.

The cities' ⅛-cent share of the gas tax, about $36,000,000 a year, is distributed by the Division of Highways on a population basis.

The counties' 1⅜ cents share, along with a portion of the motor vehicle fees amounts to about $94,000,000 a year. These funds are distributed directly to the counties by the State Controller, and their expenditure for road purposes is administered by local boards of supervisors.



Work was completed this year on this section of freeway on the Redwood Highway, US 101, near Myers Flat in Humboldt County.

Freeway Route Selection

The selection of freeway routes is nearly always a difficult task for the Highway Commission and the Division of Highways — especially in built-up areas, where there are many complex factors involved.

In many cases, any route selected may be unsatisfactory to some individuals or special groups, even though it offers the best range of services and benefits at a reasonable cost.

Although every freeway route proposal is potentially controversial, most route selections are accomplished without prolonged disagreement. Considering the many freeway routes adopted, about 400 miles a year, major controversies have been relatively rare.

This progress may be attributed to selection policies and procedures which have been followed by the commission and the Highway Division over a long period.

The object of these procedures is to insure painstaking study, careful consideration of all data, and complete public discussion of each possible route. California was one of the first states to insist that the people of a community must be informed and consulted early and often about freeway plans.

Briefly, the route selection process works like this:

General termini for state highways are set by the Legislature. Before possible alternate routes between these termini are even laid out on a map, the Division of Highways gets together with city or county planners and traffic engineers to determine the area's needs and general plans. Local government agencies are notified that route studies are starting. Informal public meetings are often held at this point, to explain the problems involved and to obtain preliminary ideas.

Working in close co-operation with local technical staffs, the division conducts extensive traffic, engineering and economic studies. All local master plan information is carefully reviewed.

These studies provide the facts necessary for the projection and evaluation of various alternate routes which might be considered.

Some alternates may be undesirable because they would adversely affect



Governar Edmund G. Brown (light suit) gets a firsthand view of freeway construction an the Santa Manica Freeway in Los Angeles. The Governor discussed construction progress with (left ta right) State Highway Engineer J. C. Womack, Assistant State Highway Engineer E. T. Telfard of Los Angeles, and State Directar of Public Warks Robert B. Bradford.



Cross-state traffic now rolls along an this new section af US 466 freeway in eastern Kern County, which was opened earlier this year.

such "controls" as schools, hospitals, cemeteries, recognized landmarks, or recreation facilities.

Other routes will be impractical for engineering reasons, or because they would cost too much in relation to anticipated benefits. Still others will be unsatisfactory because they would not provide adequate traffic service.

Finally, after study and restudy, the division boils down the possibilities to what are considered to be the most suitable choices from the standpoint of traffic service, effect on the community, economic influence, construction costs, and right-of-way cost.

These alternate routes are then subjected to intense public review at a series of map displays, meetings and hearings conducted by the Division of Highways. Often these public discussions reveal a course for additional study.

Upon completion of this additional investigation, the State Highway Engineer recommends to the Highway Commission the route which he believes offers the best combination of traffic service, economy and community or area benefits. Information on all alternates studied is also presented to the commission.

Highway Commission

The Highway Commission itself then takes the matter under consideration.

In all cases, local governing agencies are notified that if it is considered necessary or desirable, the commission will hold a public hearing in the area concerned. Even when no hearing is requested, the commission will announce its intention to adopt a route and withhold action for at least 30 days to permit submission of additional information and proposals.

In some instances, when it appears advisable, the Highway Commission will call a public hearing on its own.

All information presented at public hearings held by the commission and the Highway Division, along with the data developed during the comprehensive studies, is carefully considered in the route deliberations.

After the commission adopts a route, there is still another important step.

Under California law, the local governing body and the State must enter into a freeway agreement setting forth local street adjustments for the freeway. This gives local agencies a voice in design factors such as the location and type of interchanges and traffic separation structures.

Right-of-Way Acquisition

A total of 8,305 right-of-way transactions involving parcel acquisitions were concluded in the 1960-61 fiscal year. Of these, nearly 98 percent were negotiated settlements with property owners. Slightly more than 2 percent were concluded through court proceedings.

One principal reason for the large number of amicable settlements is the division's policy of paying fair market value for required property. No "horse-trading" is permitted and values are determined on the basis of expert appraisals.

Landscaping and Planting

California's freeways are the scene of a large number of planting and landscaping projects each year. In recent years, the annual state highway budget has contained from $4,000,000 to $5,000,000 for these projects.

Landscaping work on freeways in built-up regions usually involves the planting of thousands of trees, shrubs and ground cover plants. Often the freeway planting may be one of the largest landscaping projects ever undertaken in the community.

Freeway landscaping and planting projects are worked out by the division's staff of landscape architects to serve both functional and beautification purposes.

Planting of selected trees, shrubs and plants not only improves the appearance of a section of freeway, it also serves such functional purposes as the screening of headlight glare and noise and the prevention of erosion damage. Trees and shrubs are frequently used to help mark curves, bridges, intersections and other highway features.

A major problem in planting and maintaining roadside greenery is the cost, which is going up each year. Roadside maintenance, including the care of trees, shrubs and ground cover, now costs nearly $5,000,000 a year. The Highway Division employs hundreds of landscaping and tree specialists for this work, and extensive irrigation systems are required to sustain roadside landscaping throughout much of this semiarid State.

The division also carries out weed and fire hazard control programs designed to provide protection for agricultural and forest lands bordering state highways. These programs are often conducted in co-operation with other agencies.

Contract Data

During the 1960-61 fiscal year, the Division of Highways opened bids on 587 projects with an estimated construction value of $485,414,900 including construction engineering.

Of these 587 projects, contracts were awarded for 548 projects with a value of $440,481,700 and bids not in the best interest of the State rejected on 18 projects. Of the 21 remaining projects, 18 were awarded after the close of the fiscal year, and three rejected.

Contracts were also awarded during the year for 13 projects, valued at $13,934,500, on which bids had been received during the previous fiscal year.

The cost of right-of-way acquisition and utility relocation, exclusive of land clearance, overhead, and acquisition for other agencies, amounted to $142,431,387 for the year.

The total of $454,416,200 in contracts awarded during the year was made up of $406,178,500 for construction on state highways, $19,307,200 for work on county roads including the Federal Aid Secondary System, and $28,930,500 for maintenance, emergency repair, and work for other agencies.

The State Highway System contracts of $406,178,500 consisted of $328,080,400 from the 1960-61 Budget, and $78,098,100 from the 1961-62 Budget which were awarded under statutory provisions permitting the award of contracts as early as January 1, six months before the start of the fiscal year.

The contracted state highway work involved improvement of 1,598 miles of highways and construction of 603 bridges and separation structures.





Moture landscaping gives a park-like atmosphere to many of California's freeways. Plantings also serve functional purposes such as erosion control. The State is spending some $4 to $5 million for new plantings each yeor.

CONSTRUCTION PROGRESS

Throughout California, motorists are enjoying constantly improving travel conditions resulting from the State's high-gear program of highway construction.

Ribbon-cutting ceremonies for major highway improvements are held frequently, and large-scale highway construction projects are in progress or pending in nearly every locale.

In metropolitan areas, work is proceeding on long-planned freeways to provide alternate routes and relieve the overload on those already completed. On major through routes, new freeways are traversing or bypassing more cities, while between the cities many miles of previously built expressway are being converted to full freeway standards by addition of crossing structures. Improved sections in rural and scenic regions are being extended.

Los Angeles Metropolitan Area

In the Los Angeles region, a spectacular series of highway construction projects is concentrated on the Golden State, Santa Monica and San Diego Freeways. These three interstate freeways are essential components of the planned metropolitan system.

Projects in progress on the Golden State and Santa Monica Freeways will complete the 30-mile "loop bypass" of the central district. (See map on next page.) This facility, extending from the Santa Monica-Harbor Freeway junction to San Fernando, will provide an alternate route for a portion of the traffic now using the overtaxed central district freeways and the four-level interchange near the civic center.

The 1962-63 Budget, adopted in October 1961, contains $28,500,000 for four new projects on the Santa Monica Freeway which, along with current construction, will complete this route for 14 miles from the Santa Ana Freeway (East Los Angeles Interchange) to Sawtelle Boulevard.

Now completed, under construction or budgeted on the San Diego Freeway are 50 miles of eight-lane freeway between Westminster in Orange County and the Golden State Freeway near San Fernando.

Work is in progress on a 4.7-mile extension of the Harbor Freeway which will complete freeway development on this 22-mile route from the four-level interchange to San Pedro.

The 1962-63 Budget carries allocations for initial large-scale projects on the San Gabriel River and Garden Grove Freeways and for conversion from expressway to freeway standards on sections of the Ventura Freeway east of Ventura. Work is now in progress on the U.S. 101 Freeway through Ventura.

Widening of heavily traveled sections of the San Bernardino Freeway continued during the year. The Long Beach Freeway extension between the San Bernardino and Santa Ana Freeways was opened to traffic. Construction crews are moving ahead with two major projects on the easterly extension of the Ventura Freeway to connect with the Golden State Freeway.

The long-discussed toll bridge over the Main Channel of Los Angeles Harbor between San Pedro and Terminal Island is now under construction, after successful sale of revenue bonds to help finance the project.

Sixteen miles of freeway are under construction on the Antelope Valley Freeway (US 6) east of Solamint, and work is progressing or budgeted on units of the Newport Freeway (Sign Route 55) in Orange County.

Other Southern California Areas

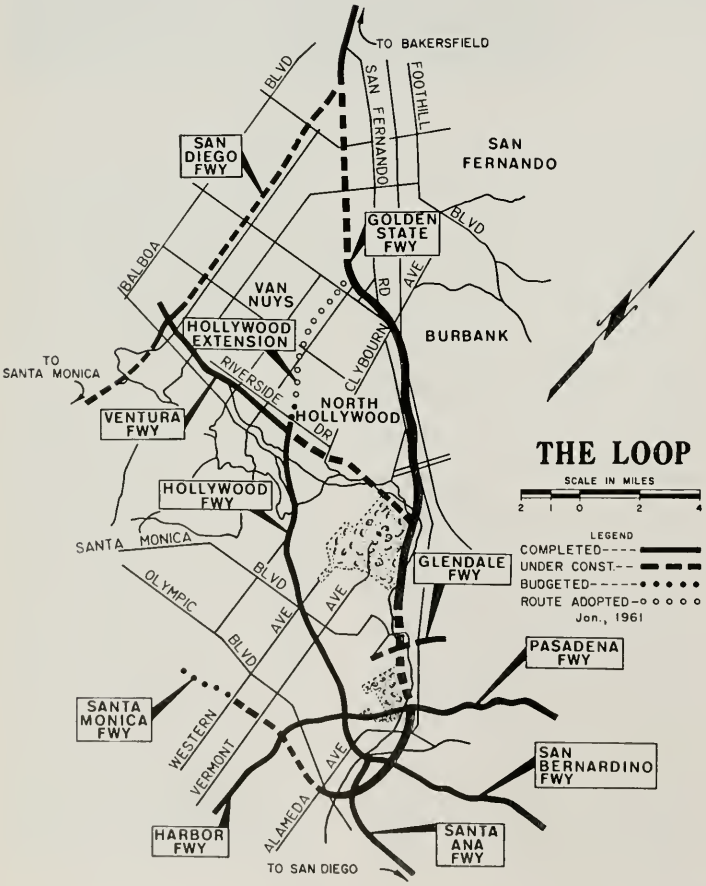
The 7.7-mile Corona Bypass on the Riverside Freeway was recently opened to traffic, and work is under way on a section of US 60 freeway in the Riverside area, extending a newly completed freeway unit.

Construction is in progress on two large scale freeway projects on US 70-99 through Redlands. This work, plus the recently completed freeway from Beaumont to Banning and a budgeted project east of Banning, will complete 125 miles of continuous freeway and expressway from downtown Los Angeles to Indio.

A long section of Interstate freeway on US 91-466 east of Baker was opened this year, and a newly budgeted project will provide an additional 23 miles, making a total of more than 50 miles of continuous freeway from east of Baker to the Nevada border. The freeway bypass at Barstow was opened this year.

In the San Diego area, US Highway 80 is nearly completed to freeway standards between San Diego and east of El Cajon. Most of the current heavy construction is centered on the future US 101 freeway through the metropolitan area. The newly adopted budget provides funds for the start of freeway construction to eliminate the outmoded section of US 101 in the vicinity of Del Mar and Solana Beach.

A seven-mile freeway job on US 80 in the Sand Hills region of Imperial County was completed recently and the 1962-63 budget provides funds for another US 80 freeway project near Mountain Springs.



San Francisco Bay Region

Many major highway projects are now under construction throughout the San Francisco Bay Area, and work will be starting in the coming months on additional improvements.

Largest project now in progress is the $17,000,000 Webster Street Tube beneath the estuary separating Oakland and Alameda. This new tube parallels the existing Posey Tube. The two underwater crossings will be operated as a divided highway when the Webster Street facility is finished, early in 1963.

Large scale projects now under construction or budgeted on Oakland's MacArthur Freeway (US 50) will provide 12 miles of continuous freeway from the Bay Bridge Distribution Structure to San Leandro.

Construction continues on the third two-lane tunnel at the Caldecott Tunnel on Sign Route 24 at the east city limit of Oakland. Work is also progressing on budgeted freeway jobs on Sign Routes 24 and 21 in Contra Costa County which will connect with the current Benicia-Martinez Toll Bridge construction.

The 1962-63 budget provides $12,900,000 for interstate freeway construction on Sign Route 21 between south of Danville and Walnut Creek.

Projects are under construction or budgeted on the Southern Freeway in San Francisco, including the extension easterly from the James Lick (Bayshore) Freeway.

Two budgeted freeway projects on US 101 north of San Rafael will complete freeway development on this route from the Golden Gate Bridge to Novato, a distance of 19 miles. Additional freeway is under construction on US 101 north of Santa Rosa.

Two nearly completed projects on the Bayshore Freeway (US 101 Bypass) in Santa Clara County will complete freeway development on this route for 49 miles from San Francisco to San Jose.

Freeway is under construction on Highway Route 105 in San Mateo, and the Division of San Francisco Bay

Toll Crossings has started the trestle work for the widening of the San Mateo-Hayward Bridge.

A 3.3-mile stretch of four-lane expressway was completed on Sign Route 17 north of Santa Cruz, and two budgeted interchange projects will convert Sign Route 1 from expressway to freeway standards south of Santa Cruz.

Central Coast Area

Work is continuing on the Santa Maria Bypass on US 101 which will eliminate the only remaining gap in 100 miles of continuous freeway and expressway from Buellton to San Miguel. Completed on this stretch during the year was the new freeway section at Pismo Beach.

Nearly completed is 8.5 miles of freeway on US 101 west of Santa Barbara, and work is under way on the Ward Memorial Highway which will serve the Goleta Campus of the University of California.

On Sign Route 1 in San Luis Obispo County, a total of 18 miles of two-lane expressway is under construction



A new section of US 99 freeway now under construction at Merced will eliminate a long-standing bottleneck on this route. The present highway (left) passes through business district via a crowded city street.



Glenn County motorists are now enjoying use of this new causeway across a Sacramento River overflow channel on the Willows-Butte City Highway. The causeway will permit year-round operation of this highway, which formerly had to be closed during winter floods.



Shown in this aerial photograph is part of a new 7-mile section of interstate freeway on US Highway 80 through the Sand Hills of Imperial County. The old highway is shown at right and the All American Canal parallels the freeway in the distance.

in projects north of Morro Bay and north of Cayucos, and the 1962-63 Budget contains an allocation for two-lane expressway at Cambria. Four expressway-to-freeway conversion projects are budgeted on US 101 in this county.

Funds are also budgeted for 11 miles of four-lane freeway on US 101 between north of Bradley and south of San Ardo in southern Monterey County.

The Greenfield Bypass on US 101 was opened during the year, and construction is under way at Gonzales to complete 46 miles of continuous freeway and expressway from north of King City to Salinas.

San Joaquin Valley

Nearly all of US 99 is now developed to freeway or expressway standards between Sacramento and Los Angeles. Four of the remaining gaps will be eliminated by current projects at Bakersfield, Merced, Modesto and Lodi. This leaves only the section at



Construction workers are building a new bridge-fill freeway crossing of the Yolo Bypass on US Highway 40 west of Sacramento. The freeway will replace an existing causeway which carries the only remaining section of undivided highway between San Francisco and the state capital.

Turlock for which design and right-of-way acquisition must be completed and funds budgeted.

Expressway conversion or freeway construction is also under way, budgeted or recently completed through and near Bakersfield, north of Pixley, north of Tulare, north of Goshen, near Traver, near Kingsburg, south of Fresno, north of Merced, south of Modesto, and at Stockton.

A large scale freeway job is in progress on US 466 west of Tehachapi in Kern County, extending a 12-mile project opened during the year. Major projects are also under way or budgeted on Sign Route 198 in Visalia and near the Lemoore Naval Air Station, on Sign Route 190 in Porterville, and on the new Interstate Route 5W bypassing Tracy on the west.

North State Region

Interstate highway construction is resulting in rapid progress in freeway development on US Highway 40. Existing expressway is being converted to freeway in the valley, and heavy freeway construction is in progress in the Sierra Nevada.

Freeway is under construction east of Vallejo and through Vacaville. Two freeway projects were completed recently between Cordelia and Fairfield. Funds are budgeted for an additional project east of Vacaville.

Construction crews are making good progress in building a new bridge-and-fill crossing over the Yolo Bypass east of Davis. This crossing will replace the present four-lane undivided causeway.

The 120-mile stretch of US 40 between Sacramento and Nevada continues to be the scene of heavy construction activity. Three freeway sections remain to be completed on this stretch—5.4 miles now under construction near Emigrant Gap; an adjacent 6.3 miles near Cisco for which funds are budgeted; and the 10-mile section over Donner Summit. A 5-mile stretch west of Baxter was completed in November. Heavy grading and structure work is now in progress in two projects on the summit section.

On the north state portion of US 99, work has been completed on a major Interstate freeway project south of Dunsmuir and work is continuing on a job which will close the last gap in 30 miles of continuous freeway and expressway in the Sacramento River Canyon.

Freeway construction is also under way on US 99 between Cottonwood and Anderson and from Red Bluff to south of Cottonwood. Funds are budgeted for freeway at Cottonwood and for the first unit of the US 99E freeway through Chico. The 1962-63 budget also carries an allocation for



This crossing structure will carry local traffic over the MacArthur Freeway (US 50) which is now under construction in Oakland.



Workers are drilling a new two-lane tunnel to supplement the existing four lanes at the Caldecott Tunnel on Sign Route 24 in and east of Oakland. When the new tunnel is completed, traffic flow will be regulated to provide four lanes in one direction during peak periods.



Traffic continued to use the old highway while work was in progress on new freeway lanes (right) on US Highway 101 west of Santa Barbara. The project is one of a series of recent major improvements on US 101 through the central coast counties.



Looking north along the future US 99 freeway route (left) and the present highway near Wheeler Ridge in Kern County. This new freeway section will be a part of a bypass freeway now under construction in and north of Bakersfield.

two-lane expressway construction on Sign Route 20 near Meridian.

The South Sacramento Freeway (US 99-50) was opened to traffic in November and a large scale freeway widening was completed on US 40-99E northeast of the capital city.

On US 50 east of Sacramento, freeway construction is under way near Folsom and just west of Placerville, while a freeway section just east of Placerville was completed in November. At the higher elevations, approaching Echo Summit, additional passing lanes and turnout areas were constructed.

Foothill and Mountain Routes

Improvements on highways approaching or crossing the Sierra Nevada and the Cascades have been completed in recent months and additional work is now under construction or budgeted.

Work is in progress on major highway improvements on Sign Route 88 east of Peddler Hill, on Sign Route 49 north on Mariposa, on Sign Route 36 in eastern Tehama County, on Sign Route 89 between Mt. Shasta and McCloud, and on the Etna-Yreka Highway southwest of Yreka. Projects have been completed recently on Sign Route 4 between Angels Camp and Murphys on Sign Route 16 southwest of Plymouth, and on US 40 Alternate in Plumas County.

Two freeway projects are under construction on US 40 Alternate near Oroville. The relocation of US 299 around Shasta County's Whiskeytown Dam and Reservoir is nearly completed. Construction crews have made considerable progress on the relocation of US 395 on Conway Grade in Mono County.

The 1962-63 budget provides funds for two-lane expressway construction on Sign Route 88-89 in Alpine County; Sign Route 88 in Amador County; Sign Route 108 in Tuolumne County; US 395 in Lassen and Modoc Counties; US 299 in Lassen and Modoc Counties, and US 299 in Trinity County. Large scale two-lane highway improvements are slated on Sign Routes 49 and 132 in Mariposa County and on Sign Route 49 in Calaveras County.



A traffic bottleneck on US 91 at Corona was eliminated during the year with the completion of this new section of the Riverside Freeway.



Work is pragressing on the relocation ol US Highway 40 to provide an interstate freeway over Donner Summit and past Danner Lake. The new freeway will replace the present twisting highway at right. As shown in the photo, part of the summit freeway will be a "split level" design with roadways separated by a stand of trees.

North Coast Region

The Collier Tunnel and approaches are under construction on U. S. Highway 199 at Hazelview Summit just south of the Oregon border.

The second unit of the Redwood Parks Freeway on US 101 near Myers Flat, Humboldt County, has been opened, and construction is under way on an additional section to the south. The 1962-63 budget provides funds for further freeway construction to complete 22 miles of four-lane freeway in the Redwood Parks area.

Freeway sections are also under construction on US 101 south of Eureka and at Fortuna. Work has been completed on the parallel bridge over the Eel River south of Scotia.

In Mendocino County, traffic is now using a new section of freeway on US 101 about 15 miles north of Willits, and work is continuing or budgeted on freeway units in the vicinity of Ukiah. Two-lane expressway construction was completed recently on State Sign Route 53 in Lake County.

Summary

Major freeway projects and other large scale improvements must share the highway construction spotlight with the hundreds of smaller projects completed each year.

Though less costly and spectacular than the heavy freeway construction, these minor projects often result in dramatic relief from traffic congestion and sharp reductions in accident and injury rates.

Motorists are quick to notice and appreciate the travel benefits growing out of the straightening of a curve, the widening of a narrow section of pavement, or the installation of traffic signals at a busy intersection.

But the major emphasis in the highway program continues to belong on the freeways. Freeways are designed to incorporate into a single, permanent facility all the devices and design features that have yet been devised to make motor vehicle travel safer, smoother-flowing and more expeditious. The freeways in operation have proved their worth, and those now under construction or being planned will do their job even better.



FREEWAYS

Modern full freeways carry more traffic in greater safety than any other type of highway. Accident and fatality rates on freeways are much lower than on conventional highways. Freeways are also more efficient. A freeway lane has three times the capacity of a normal city street lane because access is controlled and cross traffic is eliminated by traffic separation bridges. California has more than 900 miles of full freeway in operation, with another 400 miles under construction.



ABOVE—San Bernardino Freeway near Covina. RIGHT—U.S. Highway 101 at Chualar. BELOW—Hollywood Freeway in Los Angeles.



Operations

- *The construction, maintenance, equipment and materials and research departments are administered under the direction of the Assistant State Highway Engineer—Operations*

CONSTRUCTION

The availability of increased federal and state highway funds resulted in a sharp upturn in the volume of construction under way during the past fiscal year. For the first time contracts under way, excluding bridge, day labor and minor contracts, totaled over four hundred million dollars.

Special Projects

During the year, the Construction Department culminated a program which started three years ago to revamp the system of keeping the records and accounting on highway contracts. Training programs were conducted in all districts and most districts were using the new system by May 1961. Effective July 1, 1961, the new system officially became the approved method of recording-keeping and accounting on all contracts let after that date.

The construction departments in the districts are delegated the responsibility for assuring that contracts are built in conformance to the specifications. A program in which Headquarters Construction reviews the record tests, project control tests and specifications and recommends the finished product to the State Highway Engineer for his certification to the Bureau of Public Roads was instituted, although this amounted to no more than a formalization of existing procedures.

A study of tolerances which are practicable, both from the standpoint of design and construction operations, was started during the past fiscal year. This study is closely related to the testing and certification procedure outlined above.

Concrete construction was the subject of a series of training sessions. Representatives of the Portland Cement Association co-operated with the department in putting on this program.

Construction Practice

With more projects being paved by means of the slip-form paver, the added experience gained in this method of laying portland cement concrete pavement has resulted in improvements in the equipment and operations.

The trend to more and more automatic operation on road building ma- machines continues. Crossfall is automatically controlled on grading and paving machines, while profile grade control is maintained by following established guide wires, or by means of long skids or sleds which ride the grade and control the spread of material.

Additional profilograph units have been made available to the districts for their use in checking the smoothness of finished pavement.

The combination of more efficient automatic equipment for building the structural elements of the roadway, plus more effective means of inspecting and verifying the finished product, has resulted in better highways for the taxpayers.

Honor Camp Projects

During the year, the Division of Highways and the Department of Corrections continued the joint operation of Honor Camp No. 37 at Cedar

An increasing number of projects are being paved by means of the slip-form paver, a comparatively new device which eliminates time-consuming side form construction. Here the giant machine is shown in operation on the new US 99-50 Freeway south of Sacramento.



Springs, Los Angeles County; Camp No. 41 near Happy Camp on the Klamath River in Siskiyou County; and Camp No. 42 near Lord Ellis Summit in Humboldt County.

By the end of the fiscal year, Camp 37 forces had rough-graded the last 6.5 miles of roadway on the Angeles Crest Highway and had brought approximately three miles of this length to finish grade. All work proposed for this camp was to have been completed by late fall of 1961. Plans were being readied for paving the project by contract and for demolishing the camp facilities.

Camp 41 continued construction on the nine-mile portion of the Klamath River Highway between Swillup Creek and Clear Creek, and on the two-mile stretch between Wright Ranch and one-half mile west of Happy Camp. Construction was also started on the next three-quarter mile section extending to two-tenths of a mile east of Happy Camp.

Camp 42 continued work on U. S. Highway 299 between Blue Lake and Berry Summit. Of the total of 23 miles proposed, 4.1 miles have been brought to grade; grading and stabilization work were in progress on another 0.7 mile, and clearing was proceeding on other portions.

At the end of the year there were 74 inmates at the Cedar Springs Camp, 61 at the Clear Creek Camp and 42 at the camp near Lord Ellis Summit.



The Division of Highways and the Department of Corrections jointly operated road building Honor Camps at three remote locations during the fiscal year. Pictured here is Camp 42 in Humboldt County. At the end of the year, some 60 inmates were stationed at this camp for work on U. S. Highway 299.

MAINTENANCE

The total expenditure for all maintenance work on state highways including upkeep and repair of the Benicia-Martinez Ferry, was $37,742,735 in 1960-61.

Maintenance crews are responsible for maintaining California's highways in serviceable condition and for keeping the roads open when possible during times of emergency. Last year there were numerous emergencies occasioned by landslides, flash floods, and forest fires, but winter snow conditions were generally mild.

Pavement Repair, Bridge Maintenance

Throughout the year, Division of Highways maintenance crews undertake emergency road surface restoration as required, and, as a routine assignment, the repair of broken areas and the restoration to grade of depressed or distorted pavement. Work on heavily traveled highways requires careful traffic control and the placement of protective devices as a safety measure.

During 1960-61, it cost $1,864,822 for the repair of traveled way and shoulders, including work in cities, under specific fund allotments. Of this amount, $1,584,700 (direct field cost or obligation) was for the restoration of 1,175 miles of traveled way and 1,018 miles of shoulders. Included in this total is $280,122 for seal coat (screening contract) on 161 miles of roadway. These cost and mileage totals do not include routine patching and repair work undertaken by maintenance crews on a day-to-day basis.

The annual resurfacing and seal coat program, sometimes called the "thin blanket program," was carried on. Contracts for this approximately $5,000,000 yearly program are financed from construction funds.

The repair and painting of bridges on state highways, as recommended by the Bridge Department, required a maintenance fund obligation of

$692,262. Of this total, $310,426 was for work under contract and $381,836 for work by state and city forces.

Ferry Operation, Maintenance in Cities, and Roadside Cleanup

The Division of Highways continued to operate the Benicia-Martinez Ferry across the Carquinez Strait, and during the year it carried 123,812 vehicles and 158,378 passengers. The ferry was out of service for five hours in October during the annual Coast Guard inspection, and for three days in November and one day in May for inspection and repairs. A motor launch was rented to haul foot passengers at these times.

State law authorizes contracts with cities or counties covering construction, or maintenance on state highways. Under this authority, certain features of maintenance work are delegated to cities. The direct field cost for maintenance of state highways in cities was $9,160,330 for the year, including $7,569,930 for work by state forces and $1,590,400 for work by city personnel.

Publicity campaigns by public service organizations and others, the distribution of litter bags at service stations, and laws prohibiting the disposal of rubbish on highways have aided in controlling the roadside litter problem. Despite increased public awareness, roadside cleanup continues as a costly maintenance item. In 1960-61 it cost $1,638,979 for removal of roadside litter and street sweeping.

Roadside Vegetation, Tree Care and Landscaping

Additional mowers were put into use during the year, enabling maintenance workers to mow roadside vegetation at more frequent intervals and to cover greater area. Large brush mowers and chemical sprays are used to control roadside brush in coastal and mountain regions. Noxious weed elimination in most cases was handled by county agricultural departments under service contracts. At appropriate locations, clear roadside strips were maintained as a fire prevention and control measure.

The care of landscaping and functional planting along the state highways and freeways is a bigger job every year.



Although signs warn that it is against the law, "litterbugging" continues to be a serious problem. Roadside cleanup, including removal of litter such as that pictured here, costs about $1,600,000 a year.

Chemical sprays are used to control weeds during the first few years after planting. Selected fertilizers must be applied to help in the establishment of new plants and to maintain the health of mature ground cover, trees and shrubs.

Roadside plantings in some areas of the state have suffered as the result of several years' drought. Many acres of coastal ice plant were lost last year, and water tankers were pressed into action in an effort to save as much of this ground cover as possible. Many mature trees and oleander shrubs, which had been self-sufficient previously, required supplemental watering. In Southern California it was necessary to remove hundreds of eucalyptus trees that died as the result of the lower water table.

Lighting, Signals, Electric Devices

The number of highway lighting, traffic signal, and electrical devices maintained on state highways continues to increase.

There was a 13 percent increase in the number of fluorescent tubes and incandescent lamps used in illuminated signs, and a 15.7 percent gain in mercury and sodium vapor lamps, incandescent lamps and fluorescent tubes for highway lighting, exclusive of tunnel lights. There were 4,509 tubes and incandescent lamps maintained in tunnels. Overall, the State maintains 32,461 lighting tubes and lamps on state highways.

Seventy-two traffic-actuated signal controllers were added to those maintained, making the new total 1,330.

Highway Signs and Pavement Marking

To conform with Interstate Highway markings, arrangements were made during the year to re-stripe with yellow paint at specified locations such as no-passing zones and along the double center line on multilane pavement. A total of $1,353,525 was spent for traffic striping and pavement marking by state forces.

Study of the use of thermoplastic material for pavement marking continued. An experimental project was undertaken in which thermoplastic



Modern truck weighing station on U. S. Highway 99 near Wheeler Ridge in Kern County.

material was used to stencil a word message on the pavement.

Sign maintenance crews engaged in these work items during the year: New installations, 14,961; replacements, 10,691; signs washed and cleaned, 55,785; signs repaired and painted, 112,933; signs relocated or rebuilt, 13,934; signs removed, 6,826.

During the year, repair and upkeep of state highway signs cost $646,884. This does not include the cost of work performed by cities or the cost of electricity.



Maintenance crew is shown patching pavement on U. S. Highway 99E near Chico. Work of this type is part of the day-to-day routine for highway maintenance workers throughout the State.

Communications

Further improvements were made in the VHF mobile radio system in Districts I (Eureka), III (Redding), VI (Fresno), IX (Bishop), and X (Stockton), providing better coverage in these areas. The microwave radio system from Marysville to Truckee was completed except for one station. Work started on additional microwave facilities between Redding and Eureka and between Los Angeles and San Diego.

At the end of the year, the Division of Highways was operating 180 radio stations, 35 microwave stations, 85 hand-carry units, and 1,100 mobile radio units.

Private line teletypewriter equipment was replaced by a more modern system to provide greater flexibility, and to overcome technical problems. The system now consists of 20 stations connecting Sacramento offices with the 11 district offices. During the winter months, special teletypewriter receivers are connected to this circuit to provide late road and weather information to news media, automobile clubs, trucking concerns, and other subscribing agencies.

Outdoor Advertising, Transportation, and Encroachment Permits

Increases in fees authorized by the 1959 Legislature permitted operations

and enforcement activities of the Outdoor Advertising Section to be restored to an appropriate level, and accounted for a substantial gain in gross receipts. In 1960-61 there were 838 licensed advertising operators as compared to 843 the previous year. Permits were issued for 1,115 signs and 35,126 structures, an increase from the 989 sign permits and 30,978 structure permits issued for 1959-60. Gross receipts for 1960-61 were $127,104, a gain from $109,180 in 1959-60.

Some 30 percent fewer transportation permits were issued as a result of the first full year of operation under the new annual permit procedure for oversize trailer coaches. Formerly, permits were required for each trip. There was also increased use of blanket permits for construction equipment. The number of encroachment permits declined slightly from the previous year. In 1960-61, 70,306 transportation permits and 13,151 encroachment permits were issued. The previous year's figures were 92,156 and 13,415.

Truck Scales

Work started on two new truck scale yards as part of freeway construction on U.S. Highway 40 between Cordelia and Fairfield. The yard area at these locations will be sufficient for Highway Patrol brake and registration inspections.

Plans were completed by the Division of Architecture for a similar scale yard and brake station on U.S. 60-70-99 east of Banning.

Maintenance Stations

Contracts were awarded for the final phases of construction by the Division of Architecture for the Whitmore and Kingvale Maintenance Stations on U.S. Highway 40 in the Sierra. These yards were expected to be ready for the 1960-61 snow removal operations. Maintenance station buildings were also being built at Lee Vining for snow removal on U.S. 395.

Contracts were let for new maintenance station facilities at nine locations in northern California and at six places in southern California. New offices, employee cottages, equipment garages or other facilities were being built at nine stations. Preliminary work, site selection or land acquisition work was undertaken for eight new maintenance stations.

Expenditures for maintenance stations and radio system structures totaled $3,206,950, of which $250,490 was for land acquisition, $2,801,350 for improvements (does not include architecture funds), and $155,110 for repair and replacement.

Road Closures

Forest fires in the summer and fall of 1960 forced closing of the San Gabriel Canyon Road (Sign Route 39) for 10 days, and the Angeles Crest Highway (Sign Route 2) for 28 hours.

A fire on Donner Ridge August 21 caused the closing of U.S. Highway 40 for six hours near Donner Summit and of Sign Route 89 for 30 hours between Truckee and Sierraville.

The San Gabriel Canyon Road was also closed due to fire for two days in June. Fires in June also temporarily halted traffic on the Mint Canyon Highway (U.S. 6) and the Camp Angeles Highway (Sign Route 38).



A bulldozer cuts a channel through a slide which blocked Long Valley Creek and caused flooding on U.S. Highway 101 in Mendocino County. *(See picture on page 26.)*

Seattle Public Library
JAN 29 1962



This section of U. S. Highway 101 north of Willits was flooded when a slide blocked Long Valley Creek, causing water to back up. A channel was later cut through the slide to lower the water and permit reopening of the road.

A cloudburst north of Sonora Junction caused U.S. 395 to be closed for 12 hours in July. Desert flash floods during September resulted in numerous short road closures in southern California on U.S. 66 east of Ludlow, U.S. 91 near Valley Wells, and Sign Route 195 east of Mecca.

Loss by fire of a timber bridge at Segal Wash, 17 miles east of Desert Center, closed U.S. 60-70 for two days in December. A truck accident in April started a fire which destroyed a timber bridge on U.S. 66 east of Amboy. In both cases detours were available.

An unusual condition developed in February on the Redwood Highway (U.S. 101) about 15 miles north of Willits. A 500,000-cubic-yard slide on Long Valley Creek, adjacent to the highway, blocked the creek and caused water to back up and flood the roadway. The road was closed for 45 hours, with water over the highway to a maximum depth of 11 feet.

A channel was cut through the upper portion of the slide under difficult and hazardous conditions. This lowered the water level sufficiently to permit the opening of the road to controlled traffic.

Later, as a temporary measure, a 72-inch pipe was placed in the relief channel. Stream flow exceeding the capacity of this temporary pipe caused intermittent closing of the road for 55 hours during storm periods in March. A construction contract was let in the summer to install a 19-foot diameter culvert at the base of the slide near the grade of the original channel.

Slides and Storm Damages

Slides developed on a number of mountain highways during severe storms early in November. The principal routes affected were the San Gabriel Canyon Road and the Angeles Crest Highway in Southern California, and the Feather River Highway (U.S. 40 Alternate) and the

Smith River Highway (U.S. 199) in the north state.

With the exception of the north coast, rainfall during the rest of the winter was below normal, and there were few interruptions to traffic.

Snow Removal

Although snow fell at the higher elevations in October, causing some temporary road closures, the major snow clearing on mountain highways was not started until the intense November storms. The snowfall at Donner Summit in November was 72 inches. By the end of that month, the snow pack was 34 inches. Subsequent storms, however, added little to the pack. At the end of December it measured 10 inches, and it was only 13 inches two months later.

The total snowfall in the Donner Summit area for the year was 309 inches, and a maximum pack of 64 inches was measured March 28. By contrast, the amounts for the 1951-52 season were 793 inches and 314 inches, respectively. This comparison illustrates the range of the snow removal work load.

Pavement sanding operations next winter will be aided by the addition of new sand houses constructed at strategic locations, either in conjunction with major highway projects or as supplemental maintenance station facilities. The larger sand storage structures will handle about 1,275 cubic yards.

CLOSING-OPENING DATES

The closing and opening dates on mountain roads from which snow is not regularly removed during the winter:

Route	*Name*	*Closing Date*	*Opening Date*
SR 89	Lassen Park	November 11	June 3
SR 89	Luther Pass	—	—
SR 88	Carson Pass	November 12	May 4
SR 4	Ebbetts Pass	November 11	May 3
SR 108	Sonora Pass	November 3	May 12 †
SR 120	Tioga Pass	November 11	April 26 †
SR 89	Monitor Pass	December 2	April 14
SR 89	Emerald Bay Section	November 26	February 7 *
SR 120	Big Oak Flat	November 11	April 24 †

* Temporarily closed two days in February, and eight days in March.

† First openings of Sonora Pass, Tioga Pass, and Big Oak Flat were on April 27, April 21, and April 8, respectively. Subsequent storms closed these roads intermittently with final openings as shown.

MATERIALS AND RESEARCH DEPARTMENT

The work of the Materials and Research Department may be grouped under these general categories:

Standard methods of inspecting, sampling, testing and reporting on materials furnished for highway construction; special investigations; research aimed at developing new tests, new techniques and new materials; training and providing information to other engineers.

The headquarters laboratory in Sacramento carries on both materials testing and research work. Its three branches in Berkeley, Los Angeles, and Bakersfield are mainly concerned with inspection and testing of manufactured products used in highway construction. The laboratories in the 11 highway districts perform most of the soils and aggregates tests, both in the preliminary and construction phases of projects.

At headquarters laboratory, the work of the department is carried on by four operating sections and an administration and services section.

The materials and research department has responsibility for the post audit testing of materials on construction projects as required by U.S. Bureau of Public Roads regulations for projects involving federal aid funds. The same post audit testing is also performed on projects financed entirely from state funds.

Administration and Services

The administration and services section handles such activities as the general operation and supervision of the physical facilities of the laboratory and includes such functions as accounting, purchasing, photography, drafting, reproduction, the design and fabrication of new testing equipment, the preparation and revising of special reports and specifications, and the reviewing of materials and preliminary reports submitted by the districts. Approximately 1,100 such reports were reviewed.

During the past fiscal year, tours and training courses were arranged for 76 visitors, 26 of them engineers from foreign countries. Eighty-one Division of Highways engineers attended the materials and research training course, "Procedures, Testing Methods and Use of Materials for Highway Purposes."

Foundation Section

The extent of major highway construction in mountain areas has increased the investigative workload of the foundation section. In the wetter areas, elaborate and extensive subsurface drainage systems often have been found essential to the construction of stable roadways. Efforts have been continued in the search for practical and economical standards for filter materials.

New standards for "permeable materials" were set up during the year. As in past years, the section has been called upon by the districts for advice in the design of large cuts and fills and in the correction of slides.

Primarily because of the audit testing program initiated by the Bureau of Public Roads in May 1960, the number of samples processed and tested by the aggregates unit was more than twice the number recorded for the previous fiscal year. Of the approximately 5,000 samples received, 48 percent were for construction audit.

Two types of aggregate splitters were developed during the year. Extensive research studies have con-



Blasting in connection with a geological investigation using a refraction seismograph.



A Materials and Research Department crew takes a sample of pavement base and subbase on a new section of highway. The sample will be checked to make sure that specifications have been met. This auditing of materials and construction assures high quality work on state highway projects.

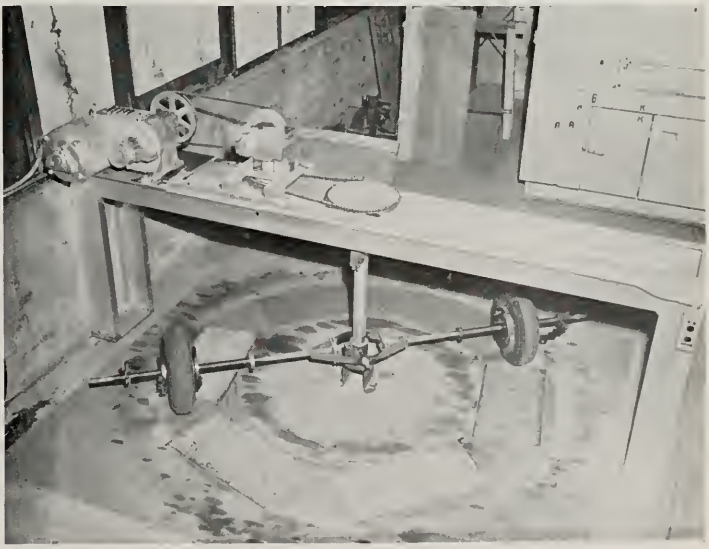
tinued to find a test method to determine the relative resistance of various mineral aggregates to harmful degradation. Fabrication of a rod-mill type soil pulverizer was completed.

The settlement devices developed several years ago to disclose the settlement of the native ground beneath embankments, and in some instances the compression within the embankment, are being installed in ever increasing numbers. Some 150 installations were completed during 1960 as compared to 50 units for the preceding year.

During the year, other construction control devices installed under fills on marsh lands and other weak or compressible foundations included piezometers, ground movement tubes, and heave stakes.

While the findings to date have not been entirely conclusive, studies of the nuclear method for determining moisture and density of the compacted fills have been made in an effort to speed construction control testing. A program of statewide field surveys to observe new construction machinery and methods was initiated.

The explorations unit made over 9,800 lineal feet of borings on 21 different jobs. The list of projects includes a number of swamp foundations (some were so bad that other locations had to be found), building



This "simulated traffic polisher" is operated in the laboratory to test various seal coat surfaces.



Exposure racks are used to test durability of signs and sign materials under the state's varying climatic conditions.

foundations, and damaging slides such as those at Crystal Springs and Towle on U.S. Highway 40.

The soils mechanics unit prepared or assisted in the preparation of 28 foundation investigation reports. Nine other investigations were in progress at the end of the fiscal year. During the year, more than 500 consolidation, 1,900 unconfined compression and 760 triaxial shear tests were performed as part of the testing of nearly 4,000 samples.

During the year, the geology unit completed 16 field jobs, consisting of nine geologic, six seismic and one resistivity survey.

Pavement Section

The pavement section does routine testing, and research work with asphalts, asphalt paving mixtures, base and subbase materials, and conducts special field investigations.

Deflection measuring crews, using special equipment, evaluated 35 projects involving 125 miles of pavement during the year for the purpose of determining the supporting capacity of the existing roadway. Recommendations for improvement of existing highways, based on deflection data obtained, were given the districts for 13 of these projects.

The engineering audit of materials and construction program cover 1,550 lane-miles on 140 projects during the year. Thickness measurements of the layers composing the structural section were made and physical tests were performed on the samples obtained. These tests determine whether the materials used in construction complied with project specifications.

Approximately 2,713 routine tests were performed on bituminous paving mixtures in connection with cooperative check testing with the district laboratories, field investigations, research work and the B.P.R. Audit Program, which alone accounted for some 600 routine acceptance tests.

Testing of aggregate bases, cement treated bases, aggregate subbase and imported borrow has also increased. A total of about 2,200 samples were tested.

A new test is being developed for the identification and measurement of expansive properties of soils proposed for use under portland cement concrete pavements.

Field and laboratory studies on paving asphalts have been continued. Special equipment has been developed for measuring wear and polish of seal coat screenings. Studies are continuing on the skid resistance of various types of pavement surfaces.

Structural Materials Section

During the fiscal year, inspectors of the structural materials section inspected and released considerable quantities of fabricated and manufactured materials, including the following: concrete pipe, 1,361,593 lineal feet; miscellaneous iron and steel, 11,169,088 pounds; corrugated metal pipe, 723,558 lineal feet; structural steel, 62,589,165 pounds; and reinforcing steel, 227,316,883 pounds.

Approximately 1,900 tests were performed on such diverse materials as structural steel, reflective sheeting, roofing insulation, ceramic tile, luminaires and ballasts, rubber gloves, and corrugated plastic headlight glare sheets.

The physical testing laboratory, in addition to testing numerous samples

of construction materials, continued studies and observations of fabrication procedures for prestressed concrete structures. This unit also continued tests of elastomeric bearing pads; began a series of tests to determine the bond of seven-wire prestressing strand to concrete and cement grout; and investigated bonding of concrete slabs to steel beams by use of epoxy adhesives in lieu of shear keys.

The welding laboratory investigated the use of ultrasonic methods to detect imperfections in fillet welds; inspected welding on various completed bridges to obtain information that might be useful in the future; investigated fatigue and mechanical properties of weld metal; tested new high strength alloy steels; and studied the effect on concrete of the eccentricity associated with lap-welded reinforcing steel.

The commodity test group continued to analyze data from field installations of median barriers for application to design and specifications. A new series of dynamic crash tests was initiated near the end of the year to supplement and check field data.

Tests and investigations of signs and sign materials were continued and tests were also performed to determine the effects of scored concrete shoulder strips (proposed as a means of alerting motorists who might drift off the highway) on vehicles.

The electrical laboratory expanded compliance testing of electrical items; performed field tests to evaluate various types of traffic counter devices; conducted service life tests of mercury vapor lamps; tested reflective materials for signs and luminaires; determined tristimulus values for sign colors; and provided instrumentation for determining vehicle response to various types of pavements.

The corrosion laboratory assisted the districts in putting into use a new test procedure for estimating the effect of the environment on culvert life. Surveys were conducted to determine necessary measures to correct pipeline corrosion. Test sites were selected and installation procedures recommended for a field test program to compare corrosion and abrasion resistance of corrugated aluminum culvert pipe and corrugated culvert pipe made of galvanized steel.

The electronics and wave propagation laboratory made acoustical surveys of noise problems in various state buildings, and performed similar surveys at several locations adjacent to freeways. A factfinding study of freeway noise problems was undertaken to determine relative effects of freeway elevation on the noise transmitted to the vicinity; and, in co-operation with the Highway Patrol, to attempt to evaluate and measure muffler noise emanating from heavy trucks. Assembly was begun on a comprehensive reference summary, in report form, of pertinent information on acoustical data applicable to highways.

Technical Section

The concrete unit has nearly completed a one-year study dealing with the relationship between drying shrinkage of laboratory test specimens and shrinkage of full-size beam sections in an outdoor exposure. No information of this type was known to be available. As a result of these tests, much of the "guesswork" and conjecture should be eliminated from appraisals of concrete performance relative to volume changes due to drying.

Since the inauguration of an aggregate evaluation program late in 1959, a total of 30 commercial aggregate sources have been tested for strength-producing properties. The purpose has been to upgrade concrete made with aggregates which were found to be substandard by increasing the cement factor. An increased cement fac-



A new series of crash tests is being conducted to obtain supplemental data on median barriers. Here a radio-controlled car crashes into a barrier at a speed of 80 miles an hour.

tor has been recommended for 12 of the 30 sources tested.

The concrete unit is also developing information on the effect of vibration on density of concrete and determining some acceptable measure of workability. Additional pavement profiles are being obtained as part of a continuing study of pavement and base performance. Hand-propelled profilographs were distributed to the districts and are currently being used in connection with controlling smoothness of new pavement.

The cement subsection performed a record number of routine tests on cement, concrete cylinders from the field, concrete curing compounds, concrete sands, and air-entraining agents. Extensive test programs were also conducted in co-operation with the National Bureau of Standards and the American Society for Testing Materials.

The cement unit has continued the development of a simple field test for better evaluation of the quality of sands used in concrete. A continued program of tests to measure volume change characteristics of portland cement has advanced to the stage that specification requirements have been prepared.

The chemical subsection, in addition to routine chemical testing, did extensive research on traffic paints and bridge paints during 1960-61. Formulations of epoxy adhesives were also developed for the installation of experimental reflective pavement markers. The use of concrete admixtures of the organic type has required the development of methods for the chemical determination, both qualitative and quantitative, of these components. The laboratory purchased an infrared spectrophotometer which has been used not only for concrete admixture analysis, but for the identification and determination of organic materials in plastics and paints. An instrument which will give controlled concentrations of ozone was purchased for the testing of ozone resistant synthetic rubbers and plastics.



District laboratories performed tests on approximately 31,000 soil samples during the fiscal year. This photograph shows a stabilometer soil test in the District I laboratory in Eureka.

Branch and District Laboratories

The branch laboratories in Berkeley, Los Angeles and Bakersfield are primarily inspection laboratories where materials are inspected and released at the point of manufacture. Only those tests necessary to insure specification materials are performed. Some of the commodities inspected and released are asphalt, corrugated metal pipe, prestressed concrete members, steel fabricated products, reinforcing bars, fencing and many other items purchased directly from the producers.

Each of the State's 11 highway districts has a laboratory. The principal functions of these district laboratories are to develop materials sites, determine the character of the soils to be excavated and used in fills along the highway alignment, determine fill slope designs, recommend foundation drainage systems, and perform control tests to determine compliance of contractor-produced materials with the job specifications. In some districts, the materials department has the additional responsibility of recommending the thickness of layers of materials required in the pavement structure. In carrying out their work during the past fiscal year, the district laboratories made approximately 9,500 borings, tested 31,300 samples and explored 554 materials sites.

EQUIPMENT DEPARTMENT

The operation of California's state highways requires a large equipment fleet consisting of 8,939 units. This includes 5,766 automotive units ranging from sedans to heavy trucks, and 3,173 construction units. The construction equipment is used primarily for maintenance purposes and includes large motor graders, loaders, and shovels as well as smaller items such as jackhammers.

The Equipment Department is responsible for the purchase, repair and eventual disposal of such equipment. There are 12 major shops throughout the State at which Division of Highways equipment is serviced and repaired.

In the past year, equipment repairs cost approximately $3,790,000. Some of the repairs were of an emergency

nature, resulting from breakdowns or operational damage. Other repairs were subject to scheduling, such as the overhaul of snow removal equipment during the summer, and the overhaul of summer maintenance equipment during the winter. The shops also handle certain special work such as maintenance and repair on movable bridges, state-owned and operated ferry boats, ventilation equipment in tunnels, and other miscellaneous items as required by the operating departments.

Specialized Equipment Design and Construction

Many specialized maintenance units and laboratory testing equipment units are not available on the open market. These must be designed and constructed by the shop organization in collaboration with the users. The department maintains a design section to handle this specialized work. A typical equipment unit developed by this section and constructed by the shops is a new bridge repair truck that is fitted with a special body constructed at the headquarters shop.

This body houses a complete complement of tools and equipment for work ranging from bridge structure repairs and ferry boat maintenance to steam plant and subway pump servicing.

The unit is equipped with a power driven front-end winch, a 300 ampere electrical arc welder, and a complete oxygen-acetylene welding outfit. To provide a working platform for overhead bridge work, a specially designed hydraulically operated scissors-type lift table is mounted on top of the truck body to provide a safe working area for three men.

The design section is also developing a special sign washing unit fitted with an overhead personnel hoist. The unit has its own water and detergent supply. It is equipped with an electric generator to provide power for buffing equipment and for various electrical tools.

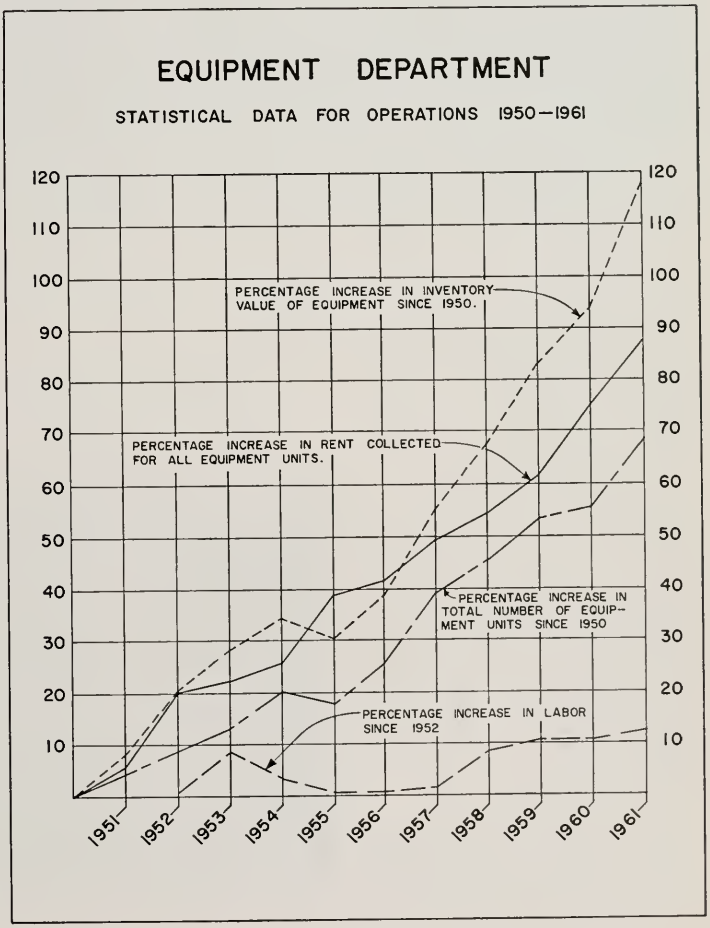
Operations

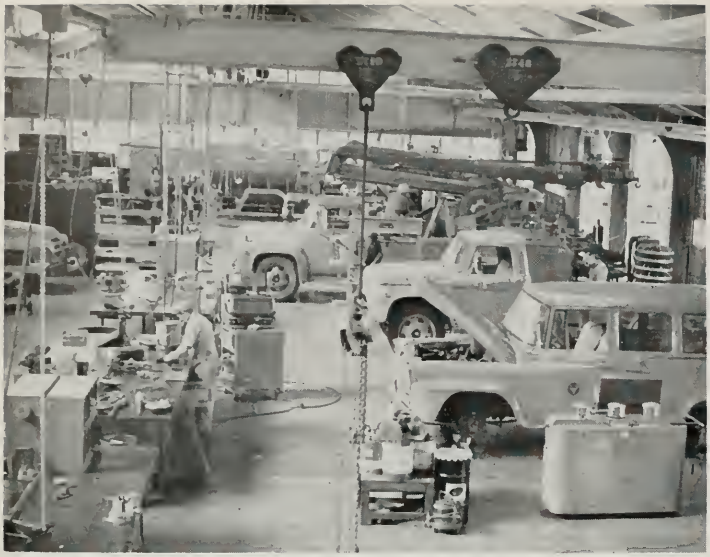
The operations section is responsible for the purchase of all new and replacement equipment. The section also disposes of worn out equipment. Newly developed equipment is studied and equipment specifications are revised accordingly. Equipment units are purchased by competitive bids. Specifications are written to include the various manufacturers of satisfactory units.

During the past year, specifications have been written for 156 different types of equipment and 1,647 units costing $5,075,831.52 were added to the equipment inventory. As equipment units reach the end of their economical life, they are disposed of. The operations section sold, by sealed bids, 921 units with an original inventory value of $2,384,973 for $367.312. This represented a return of 15.4 percent of the original cost, a very satisfactory return under present market conditions.

Parts Purchasing

A sizeable supply of parts and components must be kept in stock at all of the shop storerooms to minimize delays in the repair of equipment. The inventory value of the parts kept on hand averages approximately $600,000. To maintain this supply throughout





Interior view of Equipment Department's newly constructed truck shop in Sacramento.

the past year, the department's parts purchasing sections spent approximately $1,665,000. Intershop catalogs showing inventories of all critical and hard to obtain parts are kept up to date at all of the shops so that there is flexibility and speed in obtaining them when and where needed. A complete library of manufacturer's parts catalogs, covering all of the Division of Highways equipment units, is also maintained at each shop.

Federal Surplus Acquisition

The parts purchasing section also acquires federal surplus property. A large tonnage of steel, for fabrication work by the shops, was acquired through this surplus program. Other items obtained in this manner have been complicated and expensive machine tools, large aircraft fuel service trailers which are converted to water wagons, auxiliary engines for use on powered units, air compressors and electric generators.

Rental Rates

Rentals, charged to the operating departments for use of equipment units, cover the cost of depreciation, administration, and repairs. The rate section determines equitable rental rates for all types of equipment. Generally, new rental rates are published at the start of each fiscal year. The latest revised equipment rental rate schedule was placed in effect on July 1, 1961.

Building and Plants

The past fiscal year saw the completion of new Shop XI subshops at El Centro and Indio, a new Shop IV subshop at San Jose, additional shop facilities at Shop II in Redding, and additional shop facilities at Shop VII in North Hollywood. Construction at the headquarters shop in Sacramento included additional office space, a new truck repair shop, and an addition to the automobile repair shop. New shop construction costing approximately $2,000,000 was either completed or in process during the fiscal year.

Research and Training

The research and training section investigates problems involving equipment operation and construction and the use of fuels and lubricants, and offers training for employees of the Equipment and Maintenance Departments.

Investigations included problems on loaders, motor graders, emulsion kettles, traffic striping machines and a special mowing machine for steep side hill mowing. Specifications for several new lubricants were prepared.

Special training programs given during the year included automotive electricity, the mechanical features of equipment operation, and driver training. Training also continued in mechanical and office subjects, in addition to training taken by employees on their own time.

Summary

Equipment Department operations have grown, in the past 10 years, at a rate paralleling the expansion of the



Trimmer prepares new fender flaps for installation on heavy trucks.



Pushbuttan traffic striper used to paint the yellaw and white lines on pavement.

Division of Highways. The accompanying diagram graphically shows this growth. It is of interest to note that from 1950 to 1956 the percentage increase in rent collected and inventory value of all equipment closely corresponded. From 1956 on, the percentage increase in rent fell below the percentage increase in inventory value. The rent collected for the equipment pays for the depreciation of the equipment as well as for repairs and administration. The smaller percentage increase in rent indicates that the cost of repairs and administration became less on a proportionate basis. The proportionately lower cost of repairs may be attributed to more efficient personnel, equipment and operation.

The chart also indicates that from 1952 to the present time, there has been an increase of only 13 percent in the number of employees.

EQUIPMENT DEPARTMENT SUMMARY

	June 30, 1960	*June 30, 1961*
Equipment repairs	$3,644,496.54	$3,792,216.82
Miscellaneous expense	582,293.33	633,685.38
Administration and other expense	958,586.96	1,048,065.57
Depreciation expense	2,463,367.02	2,819,928.05
Total expense	$7,648,743.85	$8,293,895.82
Total income	7,410,123.22	8,222,445.00
1960-1961 excess of expense over income		$71,450.82

Inventory: The original investment in equipment is as follows:

Trucks and Passenger Vehicles	
All trucks, ½ ton to 10 ton	$12,113,609.03
Buses, jeeps, and station wagons	344,508.16
Passenger automobiles	3,478,814.74

Maintenance and Construction Equipment	
Motor graders	$4,296,114.15
Rotary snowplows (truck mounted)	1,681,454.60
Rotary snowplows (motor grader mounted)	131,649.71
Shovels, power	426,070.84
Loaders	1,886,559.24
Tractors	906,872.15
Snowplows, push	639,002.50
Compressors	321,253.87
Miscellaneous other equipment: rollers, mixers, trailers, pumps, drills, mowers, etc.	4,452,733.59
Total	$30,678,642.58



Night construction on the Webber Creek Bridge which will be part of a new section of U.S. 50 freeway west of Placerville.



Partly completed bridge on the section of US 299 in Shasta County which is being relocated to skirt the future Whiskeytown Dam and Reservoir.

Nearly completed interchange at junction of Golden State and Glendale Freeways in Los Angeles.



• Administration

- *The Assistant State Highway Engineer, Administration, exercises control over the following functions: Office Engineer; Federal Aid Secondary and County Co-operative Projects; City and Co-operative Projects; Service and Supply; Management Analysis; and Systems Research*

OFFICE ENGINEER

The Office Engineer is responsible for a wide range of administrative activities including preparation, review or processing of plans, estimates, and bid and contract documents; budget and expenditure control; administration of federal funds; right-of-way engineering; industry contacts; bidder prequalification records; reports and statistics, and general files.

Budget and Project Control

Engineering control of the state highway budget involves procedures to insure that provisions and amounts specified in the budget are observed; preparation and processing of contract documents; preparation of final documents submitted to the California Highway Commission; issuance of work orders; and maintenance of construction records.

During the year, 418 financial votes were prepared for commission action; 589 projects were advertised for bids with an estimated cost of $455,473,700; and 561 projects were determined to be satisfactory for contract award.

In addition to the major contract work, the financing of 320 minor and informal contracts, having a total value of $534,400, was cleared.

Plans and Estimates

This unit is responsible for the review and co-ordination of plans and specifications to assure that they are in complete agreement before the projects are advertised for bids.

Estimates of cost on all projects are reviewed at various stages up to opening of bids.

Progress and final estimates of work done by contractors are checked and processed by this unit, as are contract change orders. On June 30, 1961, there were 353 contracts valued at $615,532,300 under way.

Draftsmen attached to this unit prepare maps for the various projects, prepare summary of bids received, and draw sketches for various uses including work for other state agencies. The map included in the annual report supplement is prepared by this unit.

Specifications

Specifications were prepared for more than 600 projects during the year. In addition, specifications were established for future projects to expedite advertising for bids when funds are available.

The Division of Highways Standard Specifications for highway projects, placed in use in January 1960, are being revised to include late improvements in construction methods, and new materials and equipment. The revised specifications were expected to go into effect in July 1962.

Right-of-Way Engineering

The Right-of-Way Engineering Section works in close co-operation with the Right-of-Way Department. It also works closely with the Division of Contracts and Rights-of-Way for advice in preparing complex condemnation resolutions and in satisfying legal requirements in relinquishing superseded highways, frontage roads and other local roads, and in abandoning superseded roads.

Right-of-way requirements for the year called for preparation and engineering review of 573 condemnation resolutions involving 3,584 parcels of

This high standard county highway was built by Sacramento County on Watt Avenue under the Federal Aid Secondary County Road Program. The four-lane bridge (center) spans the American River.



property. This represents about 46 percent increase in the volume of this type of work over last year.

Property no longer required for state highway purposes is transferred to other ownership, either by abandonments, relinquishments or director's deeds. To accomplish these transfers of ownership, it was necessary to prepare 23 abandonment votes and 80 relinquishment votes for California Highway Commission action. The total length of superseded highways, frontage roads and other local roads relinquished or abandoned during the fiscal year was 151 miles.

The descriptions for 829 Director's Deeds were certified for correctness prior to processing the deeds for commission action.

Reports and Statistics

The reports and statistics unit maintained statistical records pertaining to the 561 highway construction contracts awarded during the fiscal year. Records were kept for use in preparation of the quarterly California Highway Construction Cost Index, and for use in forecasting future materials requirements. Weekly and monthly reports for management purposes also were prepared showing the value of budgeted and non-budgeted programs, and of other projects for which bids were received.

The contracts placed under way during 1960-61 covered a total of 1,431 center-line miles of state highway, including resurfacing. In addition, the Department of Public Works awarded contracts for construction on 167 miles of federal-aid secondary county roads.

Prequalification of Contractors

Prequalification is required of all contractors who desire to bid on state highway projects estimated to cost more than $50,000. The prequalification rating, representing the maximum bidding capacity for each of the several types of work which a bidder is capable of undertaking, is established from a review of each contractor's statement of experience and financial condition.

The total number of contractors prequalified to bid on the various types of state highway construction decreased from 987 on July 1, 1960, to 913 on July 1, 1961. This decrease is partly due to the waiving of the prequalification requirement for projects estimated to cost $50,000 or less. The combined bidding capacity of these 913 prequalified contractors is $2,435,440,000, which is $72,214,000 more than a year ago.

The following tabulation gives the number of contractors prequalified by the Division of Highways on June 30, 1961, arranged by the several brackets of bid ratings:

Rating	*No. of contractors*
$10,000,000 and over	76
5,000,000 to $10,000,000	129
2,500,000 to 5,000,000	214
1,500,000 to 2,500,000	293
1,000,000 to 1,500,000	365
500,000 to 1,000,000	519
250,000 to 500,000	697
100,000 to 250,000	715
50,000 to 100,000	913

Bids and Bidders

The average number of bidders per project during the year was 5.5, a slight drop from last year's level of 6.1. The highest monthly average of 6.6 was in February 1961. The low of 4.7 was in May 1961. The contracts awarded during the fiscal year have been arranged in eight value ranges as shown in the accompanying "Contract Value Range" table. Included in the table is the number of projects making up each bracket and the percentage it bears to the total. Similar information is shown regarding the value of the projects in each group.

Construction Cost Index

The California Highway Construction Cost Index reflects changes in highway construction costs. The index is founded upon weighted average contract prices for seven principal construction items in place, all referred to the base year of 1940 with a value of 100.

The California Highway Construction Cost Index for the four quarters of the 1960-61 fiscal year showed a variation in costs between a low of 228.5 and a high of 252.8. The year began with an index value of 229.1 in the third quarter of 1960, dropped to 228.5 in the fourth quarter, increased slightly to 229.6 in the first quarter of 1961, and then climbed to 252.8 in the second quarter of 1961. Over all, the index reflects a trend of stable prices during the year. The increase in the second quarter of 1961 was partly caused by projects in mountainous areas where difficult conditions tend to increase price averages and partly by increases in materials and wages which have occurred in the construction industry.

The accompanying graph shows a comparison between the California In-

STREET AND HIGHWAY MILEAGE

Various highway and street mileages, with which the Division of Highways is directly or indirectly concerned, are shown below:

	Miles	*Miles*
Total State Highway System (including portions of city streets and FAS System)		16,307
Highways proposed for construction where roads do not exist		2,282
Constructed state highways		14,025
Federal-aid System		
Primary rural (12-31-60)	7,967	
Primary urban (12-31-60)	1,496	
Total		9,463
Federal-aid Interstate System (included in above)		2,179
Federal-aid Secondary System (6-30-61)		
On state highways	3,843	
On county roads	8,172	
Total		12,015
County primary road system (6-30-61)	24,308	
Other county roads (6-30-61)	45,530	
Total county maintained system		69,838
City streets (estimated 12-31-60)		30,397
City streets on state highway system		1,686

dex, the Bureau of Public Roads Composite Mile Index, and the Engineering News-Record Construction Cost Index. The small fluctuations of the past several years in the Composite Mile Index appear to indicate the continuance of a trend toward stabilization of prices. The bureau index, based on a greater number of projects on a nationwide basis, does not reflect the pronounced rises and falls to be found in an index where local conditions are a controlling factor, as in the California Index. The Engineering News-Record Construction Cost Index, which includes many large construction projects other than highway work, continues to show a steady rise.

Federal Aid

A total of $273,564,197 in federal aid funds was apportioned to California for 1961-62 under the Federal-aid Highway Acts of 1958 and 1960. This included $19,660,098 for primary highways, $9,303,650 for secondary routes, $24,529,637 for urban routes, and $220,070,812 for interstate highways. The federal matching ratio on primary, secondary and urban projects is 59.86 percent. On interstate projects the federal ratio is 91.58 percent.

At the start of the fiscal year, construction was in progress on 82 contracts with a total cost of approximately $326,301,000 financed with federal-aid primary, urban and interstate funds in the amount of $254,974,000.

Sixty construction contracts involving $19,583,000 of primary funds, $6,097,000 of urban funds, and $71,204,000 of interstate funds were completed during 1960-61. These amounts, together with the required state matching funds, bring the combined total cost of such improvements completed during the year to approximately $130,080,000.

Seventy-eight contracts were awarded with a total cost of $268,503,000, involving primary, urban and interstate federal aid funds totaling approximately $210,317,000. Fifty-eight of these contracts provide for improvements on the National System of Interstate Highways with a total cost of $180,709,000, of which the federal share amounts to $160,755,000.

Right-of-way project agreements with the Bureau of Public Roads increased the total of interstate federal aid funds obligated for participation in right-of-way acquisition costs by $67,932,000 to a total of $298,321,000.

Service Contracts

Nearly 4,500 service contracts were processed involving a total expenditure of $6,500,000.

This type of contract (formerly called service agreement) is used for renting equipment and obtaining certain services. Its use is confined to work not covered by the State Contract Act and not adaptable to minor contracts, right-of-way clearance contracts or other prescribed procedures.

The principal use of service contracts, involving an expenditure of nearly $1,700,000, was for the rental of equipment for highway maintenance, for highway construction by honor camps, and for occasional day-labor highway construction projects.

Certain types of services are also obtained under standard agreement. During the fiscal year, 82 standard agreements were processed covering such services as appraisers and expert witnesses in right-of-way matters and professional consultants in unusual design and economic investigations.

Other Functions

The Industry Contact Section obtains prevailing wage contract data from contractor and labor organizations; collects information for the establishment of equipment rental rates to be used on force account work; represents the Division of Highways at hearings of the California Public Utilities Commission concerning dump truck rental and asphalt hauling rates; and processes minor contracts, right-of-way clearance contracts, informal bid and emergency contracts, and service contracts.

Small projects for which the cost will not exceed $5,000 are handled by the districts. A total of 359 minor contracts with a value of almost $557,000 were awarded during the fiscal year. The average amount per contract was approximately $1,550.

STATE HIGHWAY MILEAGE BY SURFACE TYPE

TYPE	NORTH			SOUTH			TOTALS		
	Outside cities	Inside cities	Total	Outside cities	Inside cities	Total	Outside cities	Inside cities	Grand total
Concrete	512.241	159.292	671.533	550.480	341.010	891.490	1,062.721	500.302	1,563.023
High bituminous	4,117.935	482.330	4,600.265	3,424.718	605.262	4,029.980	7,542.653	1,087.592	8,630.245
Low bituminous	1,435.429	28.896	1,464.325	795.796	8.457	804.253	2,231.225	37.353	2,268.578
Oiled earth, gravel	653.253	2.383	655.636	684.913	4.329	689.242	1,338.166	6.712	1,344.878
Graded and drained earth	39.339		39.339	23.162		23.162	62.501		62.501
Bridges	70.052	33.896	103.948	31.525	19.735	51.260	101.577	53.631	155.208
Totals—Constructed road	6,828.249	706.797	7,535.046	5,510.594	978.793	6,489.387	12,338.843	1,685.590	14,024.433
Unconstructed road	1,195.797	125.713	1,321.510	738.795	222.066	960.861	1,934.592	347.779	2,282.371
Total highway system	8,024.046	832.510	8,856.556	6,249.389	1,200.859	7,450.248	14,273.435	2,033.369	16,306.804

As in past years, contracts were awarded to clear rights-of-way in advance of construction, except where improvements were disposed of through sales.

For altering and moving buildings, relocating irrigation systems and fences, and drilling wells, 37 contracts involving a total cost in excess of $1,000,000 were awarded.

Contracts for the demolition of buildings numbered 682 with a total cost of approximately $900,000. Of the total of 719 right-of-way clearance contracts placed underway, 698 have been completed and 21 are still active.

CONTRACTS BY TYPE

This tabulation gives the number of contracts with mileage by types awarded during the 1960-61 fiscal year.

No. of contracts		*Centerline miles*
37	Portland cement concrete	169.0
182	Asphalt concrete	1,036.1
1	Road mix	1.4
10	Seal coat	204.6
4	Grading	20.3
84	Traffic signals and lights	—
38	Bridges	—
146	Miscellaneous	—
502	Total	1,431.4

NOT ON STATE HIGHWAY SYSTEM

County Roads—Federal Aid Secondary

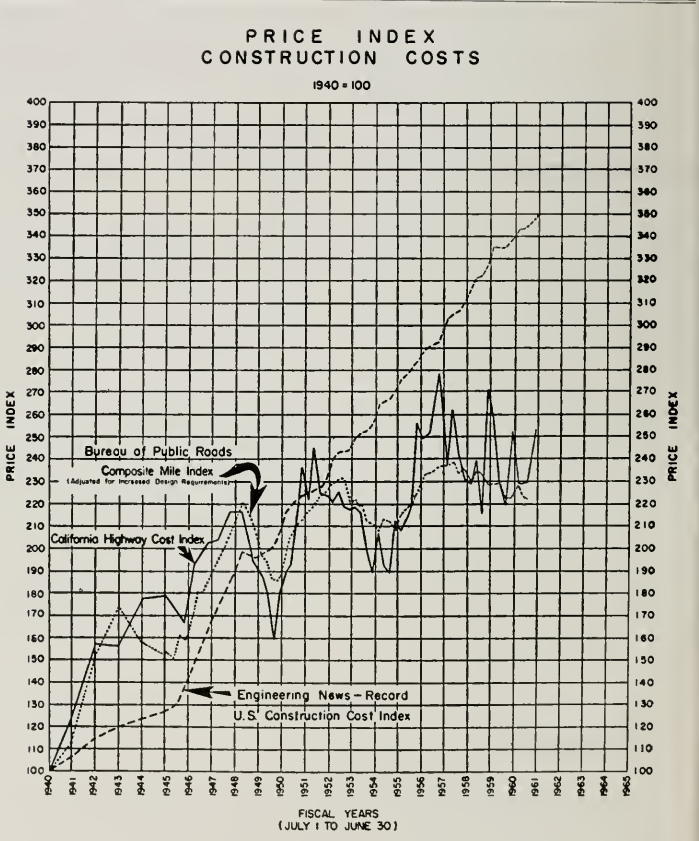
No. of contracts		*Centerline miles*
44	Asphalt concrete	135.1
2	Road mix	9.5
2	Seal coat	2.6
3	Grading	19.5
5	Bridges	—
1	Miscellaneous	—
57	Total	166.7

STATE PARKS, ETC.

No. of contracts		*Centerline miles*
2	Miscellaneous	—

CONTRACT VALUE RANGE

Range	*Number of projects*	*Percent*	*Value of projects*	*Percent*
Under $5,000	231	41.2	$4,434,900	1.2
$50,000 to $100,000	74	13.2	5,357,500	1.4
100,000 to 250,000	100	17.8	15,875,100	4.2
250,000 to 500,000	51	9.1	18,019,000	4.7
500,000 to 1,000,000	33	5.9	22,617,100	6.0
1,000,000 to 2,500,000	23	4.1	37,760,700	10.0
2,500,000 to 5,000,000	28	5.0	105,395,300	27.8
Over $5,000,000	21	3.7	169,220,600	44.7
Totals	561	100.0	$378,680,200	100.0



COUNTY AND CO-OPERATIVE PROJECTS

The Federal-Aid Secondary Roads Unit processes all matters pertaining to the FAS Program, acting as liaison between the U.S. Bureau of Public Roads and the counties. This unit also administers county and city projects on the urban extensions of the FAS system, local flood relief projects, county road system records and joint highway district projects.

The last joint highway district No. 9, covering State Sign Route 1 between Santa Cruz and San Francisco, was dissolved during the year. The last project, from one mile north of New Years Creek to Whitehorse Creek, has been completed.

The FAS Program

The Federal-Aid Highway Act of 1944 initiated a program of construc-



This new Klamath River Bridge at Martins Ferry, Humboldt County, was designed and built by the county as a flood repair project.

tion on a system of principal secondary and feeder roads. As of June 30, 1961, there were 12,015 miles of federal-aid secondary routes in California, including 3,843 miles on state highways and 8,172 miles on county roads. During the year, there was a total increase of 161 miles in the system, 160 miles of which were county roads.

Fifty-nine county federal-aid secondary contracts were awarded at a total cost of $17,401,404. These funds covered construction on 159 miles of road and 29 bridges.

Federal funds for secondary highways, authorized for the 1961-62 fiscal year, were apportioned to the State on December 30, 1960. California received $9,303,650 of which $8,457,807 was reapportioned to the counties in accordance with law. Under state statutes, the Division of Highways retains 11 percent of the total allocation for construction on FAS state highways, and 1½ percent for planning purposes.

The Urbon Extension Program

This program, authorized by the 1959 Legislature, has now completed its first year of operation. Urban extensions of the federal-aid secondary system are major local arterials integrated with the state freeway network.

The Highway Commission may allocate state highway funds to pay one-half the cost of extending improvements on county federal-aid secondary roads into or through urban areas. Allocations are made on a project basis for approved sections proposed for state assistance by cities or counties.

All the projects approved to date have qualified on the basis of traffic volumes for development to multilane divided status. Their improvement to this modern standard will provide adequate connectors to freeways.

All five projects approved for the 1960-61 fiscal year were placed under construction, utilizing $691,250 of state highway funds.

Allocations totaling $1,292,000 were made by the Highway Commission for 1961-62 to pay half the cost of 10 projects.

County-Maintained Roads

The total county-maintained mileage on June 30, 1961, stood at 69,422. While the annual certification of county-maintained road mileage, issued to the State Controller, showed a net increase of only 416 miles, new roads totaled 1,197 miles. There were 781 miles of road deleted due to new cities being formed, annexations to cities, reservoirs being flooded and miscellaneous abandonment.

County primary road system changes approved by the department resulted in a net increase of 854 miles, bringing the total to 24,308. This large increase was due mainly to the re-evaluation of the county road system in five counties.

CITY AND CO-OPERATIVE PROJECTS

The primary function of the City and Co-operative Projects Engineer is the administration of the gasoline tax funds allocated for use on city streets.

The California Streets and Highways Code provides that ⅛ cents tax per gallon under the fuel tax law shall be allocated annually by the California Highway Commission from the State Highway Fund for expenditures on city streets.

The code also provides for the annual allocation of amounts ranging from $1,000 to $20,000 for each city, to be spent exclusively for engineering costs and administrative expenses in respect to city streets.

Expenditures of state allocated (⅛¢) funds are required by statute to be made within each city in the proportion which the total population of such city bears to the total population of all cities in this State.

Improved Agreement Procedure

A master type of agreement for the budgeting and expenditure of state allocated funds was initiated this last year. Its use has greatly simplified the procedure for processing budget approvals of proposed state allocated expenditures. Such agreements have been signed with almost all the cities.

A total of $42,482,433 was budgeted for city projects during the fiscal year, including $24,988,765 for surveys and plans and construction, $7,521,661 for rights-of-way and $9,972,007 for maintenance. (See accompanying tabulation of budget transactions.)

State-allocated (engineering) funds budgeted for engineering and administration in connection with city streets amounted to $1,339,298 for the fiscal year.

Major City Street Systems

According to the statutes, each city council is required to select a system of major city streets subject to approval of the Department of Public Works. Three-fifths of the state-allocated (⅛¢) funds are to be spent for the construction of streets included in these systems.

Master plans being developed by many cities and counties provide a good basis for the selection of these major city streets by city councils. During this past year, many cities have updated their major city street systems.

During the year, 517 sets of plans, specifications and estimates were reviewed and approved for construction. These plans provided for the improvement of 224 miles of streets at an estimated cost of $27,891,837.50.

Population Figures, New Cities

On December 2, 1960, the population figures of the April 1, 1960 federal census were announced. The total for the incorporated cities was 11,157,059.

Total estimated population of the 372 incorporated cities at the end of the year was 11,443,805 or approximately 70 percent of the estimated 16,445,000 total state population.

The population in cities increased 229,110 during the year or 2 percent over the June 30, 1960 estimate.

There were 1,050 city annexations during the year, and six new cities were formed by incorporation. The new cities, with dates of incorporation and estimated population, are San Dimas, Los Angeles County, August 4, 1960, 7,128; Farmersville, Tulare County, October 5, 1960, 2,427; Cudahy, Los Angeles County, November 10, 1960, 11,202; Arvin, Kern County, December 21, 1960, 3,804; Weed, Siskiyou County, January 25, 1961, 4,686; and San Juan Capistrano, Orange County, April 19, 1961, 1,848.

FUNDS AVAILABLE TO CITIES

State allocated (⅛¢) funds available to cities for budgeting during this fiscal year:

Unbudgeted funds in city treasuries and in the State Highway Fund, June 30, 1960	$11,225,423.15
Apportionments during the fiscal year	33,812,485.46
Savings on completed projects and cancelled projects and interest and rental receipt accruals	7,138,861.35
Total available for budgeting during the fiscal year	$52,176,769.96
Actual amount budgeted	42,482,432.94
Carry-over for budgeting in the 1961-62 fiscal year	$9,694,337.02

SERVICE AND SUPPLY

The Service and Supply Department is organized to relieve the engineers of the division of many necessary functions not directly connected with the design, construction and maintenance of highways.

Procurement and Warehousing

Warehouses are operated in Los Angeles and in Sacramento to conveniently serve all portions of the State. A total of $4,975,843 of warehouse disbursements was made during the year. The average inventory was $2,289,203.

The Division of Highways requisitioned and the Department of Finance purchased $16,449,226 in commodities ranging from ordinary office supplies to maintenance and construction material, including printing and specialized engineering equipment. Purchases for warehouse stock are included in these figures. The purchases do not include automotive or heavy construction equipment which is obtained by the Equipment Department.

As in past years, a large number of surplus U.S. government items were obtained. New maintenance station

cookhouses and bunkhouses have been outfitted from these sources of surplus at considerable savings.

The continuing favorable steel market made it unnecessary for contractors to borrow steel or culvert pipe from the division. A minor amount of "H piling" was furnished from stock as state-furnished material on small bridge contracts where the contractors could not economically obtain small quantities from the steel mills.

Other Auxiliary Services

The Headquarters Reproduction Section had its busiest year. The Blueprint Unit printed 8,150,400 square feet of the blue prints, diazo bluelines, brownlines, duplicate cloth, and direct positive film and paper.

The Duplicating Unir ran a record number of 107,846 masters for a total of 13,525,334 impressions.

New sign acquisition procedures were adopted. Various operations of procurement and inspection are handled by Service and Supply, with the Traffic Department responsible for sign design.

Signs for new projects are ordered well in advance of the anticipated date of installation, stored in the Los Angeles warehouse and shipped at the request of the ordering office when the contractor is ready to install them. This procedure protects the signs and insures delivery at the proper time in good condition.

The repair of transits and levels, done under service contract on a low bid basis, has resulted in maintaining in top condition the 1,200 transits and levels used by various survey parties.

During the current year master service contracts have been entered into for the repair of other engineering equipment including theodolites, self-leveling levels, and geodimeters.

Experimental work continued with traffic counter tubing, in an effort to obtain a hose that will give accurate counts over a reasonably long life (2 million vehicles).

The property and equipment inventory for headquarters offices consisted of approximately 30,000 items valued at about $3,000,000.

The Service and Supply Department is responsible for the building



Sacramenta used five-eighths cent gas tax funds to help finance canstruction of this Sutter Road Overpass and appraaches. State highway funds from a special railroad grade separatian construction fund were also included in the financing, along with railraad funds.



Approximately $900,000 in five-eighths cent gas tax funds were spent on the recent impravement of Washingtan Street in San Diego.



New section of county expressway on Washington Street and Bartan Road in San Bernardino County, constructed under the FAS program.

services, operation and maintenance of the Public Works Building in Sacramento and the service and supply warehouses. It furnishes advisory services for building and office layout as well as for operation, maintenance and minor improvements at the district office buildings.

An engineering function of Service and Supply is the salvage and utilization of construction materials. An engineering inspection is made of each bridge structure or other highway facility which is to be removed during highway construction operations to determine which materials are structurally and economically sound for salvage and future use.

The records center at Sacramento had 16,455 cubic feet of records in storage at the end of the year, an increase of 2,932 cubic feet for the year. Records sold as waste paper totaled 54 tons, of which 25 tons were tab cards. The net unit cost of records storage at the Records Center dropped during the year to 92 cents per cubic foot per year including personnel costs. Exclusive of personnel, storage of records in the center costs 21 cents per cubic foot compared to $5.53 per cubic foot in office space.

Liaison between the State Printing Plant and the Division of Highways regarding printing has been broadened and strengthened. In the interest of economy, an effort is being made to standardize forms to the greatest extent possible. Over 2,600 orders of various types, exclusive of contract special provisions, were placed with the State Printing Plant this year and others were placed with outside vendors through the Department of Finance.

The Photographic Laboratory has continued to give photographic coverage of highway construction projects, traffic patterns, and roadway and structural conditions.

Business Volume

Purchases—Districts and Headquarters (not including warehouses)

Regular purchase orders	$9,320,794.95
Subpurchase orders	1,904,258.66
Total	$11,225,053.61

Warehouse Operations

Purchases	$5,224,182.68
Disbursements	4,975,842.52

Inventories

Stores—district office	$1,857,565.91 *
Warehouses	2,352,443.20

* Does not include $74,719.87 in Headquarters Radio Supplies (Departmental Communication Engineers—Highway Radio Shop).

The following is a resume of the allocation and disbursement of funds for acquisition of nonrental equipment during the 1960-61 fiscal year:

Allocated	$1,100,000.00
Funds expended	1,099,947.78
Funds reverted	$52.22

The nonrental inventory as of June 30, 1961, amounted to $13,880,752.30.



The Feather Lake Highway in Shasta and Lassen Counties was improved to modern standards under the Federal Aid Secondary County Road Program and recently became part of the State Highway System.

MANAGEMENT ANALYSIS SECTION

The purpose of this section is to improve the efficiency of the division's work by making assigned studies and recommendations, and providing advisory services on administrative and management problems in the Division of Highways, both in headquarters and in the districts.

Improvements in the sign requisition procedure, as well as reductions in sign records resulted from one study. Assistance was given to a recommended sign task force which followed up on other areas in order to streamline additional aspects of sign procedure.

Development of a railroad agreement flow chart assisted personnel in better understanding the entire process and provided a step toward reducing the processing time.

As a result of another study, a directive was issued outlining the responsibilities of various offices in the processing of co-operative agreements.

A number of file studies completed by the staff assisted the districts and headquarters offices as well as the director's office in better use of manpower and space. Results of previous studies resulted in over $40,000 in savings of space in 1960.

Improvements were also made in the manner of assembling statistical information for these file studies, thus permitting increased efforts in the total records program, including a more current updating of records retention schedules.

Because of the division's advances in solving the records problem and because of the impetus given to a statewide records program by the Governor, a staff member was assigned to co-ordinate department-wide effort in reducing the cost of record keeping.

A manual for use of headquarters personnel as to how to use the Records Center and recommendation for improvement of the operations of the center has been developed.

The first complete and comprehensive index of all circular letters was issued. This has provided a ready source of reference of official instructions not contained in manuals. A revised procedure placed in effect will reduce the cost of preparation of the second annual index.

A secretary's manual for headquarters offices has been drafted and submitted to the users for comment and revision. This manual will lead to a clearer understanding and a more uniform operation of division secretarial procedure.

The fact gathering phase of the Procurement and Warehouse study was completed. Improved procedures and reduction in cost are expected to result from this study.



A Sonoma County FAS project on Trenton Road included construction of this 500-foot bridge which spans Mark West Creek and two roads.

SYSTEMS RESEARCH

The position of "Systems Research Engineer" was created in May 1961. The State Highway Engineer, in establishing this position, stated that the primary purpose was a critical and searching examination into all phases of engineering costs to make certain that engineering operations are conducted on an efficient, effective and economical basis.

Since a study of engineering costs and productivity is intimately related to and dependent on proper and accurate cost accounting, much of the time and energy has been devoted to this phase of the problem in the initial stages of the study.

There has been close co-ordination with the Accounting Department in setting up the procedures for electronic data processing in Division of Highways accounting. This change should make cost records more meaningful and timely for analysis of engineering and other costs.

Studies are also being conducted in improving highway engineering productivity through the use of the latest equipment and processes of electronics.

While California has been one of the leaders in adopting modern technological methods to increase engineering productivity, scientific progress is now so rapid that continuous appraisal is necessary to make certain that early and full use is made of all the applicable time-saving methods and devices developed in this field.

• Planning

● *The functions of advance planning, programs and budgets, design, traffic, photogrammetry and highway planning survey are the responsibility of the Assistant State Highway Engineer, Planning.*

ADVANCE PLANNING

The Advance Planning Engineer is in charge of the advance planning and the photogrammetric sections.

The advance planning section processes project reports, co-ordinates steps involved in route adoptions and freeway declarations, processes freeway agreements, and works with other agencies in planning matters.

Recently completed freeway on U. S. Highway 101 in northern Humboldt County.



Project Reports

A project report is made after an engineering investigation and analysis of a specific project. The report sets forth the reasons for and nature of the planned highway improvement and the proposed manner of accomplishment. Approximately 302 projects were processed during the year.

Project reports constitute both a starting point and a control mechanism in planning and budgeting and provide information needed to establish basic design features. They are prepared in the districts and reviewed at the Sacramento headquarters.

Freeway Routes

The development of an integrated system of freeways, one of the most important phases of modern highway planning, has been emphasized in California for many years. It involves careful consideration of community values and potential land uses, as well as cost, traffic needs and benefits.

In accordance with long-established policy of the California Highway Commission, local authorities are advised by the Division of Highways of the start of freeway route studies and are also kept informed of the general features of proposed freeway units as the studies progress. Local master plans are consulted. When studies have progressed sufficiently on a specific freeway section, the division holds a public meeting to present facts and obtain local reaction and other pertinent information. (The freeway route selection process is discussed earlier in this report on page 11 and the formal policy statement is included in the statistical supplement to this annual report.)

Transcripts of proceedings of public meetings together with reports on the results of conferences held in conformance with commission policy are made available to the Highway Commission for consideration in the determination of freeway routings.

During the fiscal year, the district staffs of the Division of Highways held 53 formal public meetings to discuss proposed freeway routings. Numerous conferences with city and county officials and their technical staffs were also held during this period, as were several hundred preliminary informational meetings and map displays. In addition, the California Highway Commission itself held five public hearings during the year, two at the request of the local authorities and three on its own initiative. (These public meetings and hearings are listed in the statistical portion of the annual report.)

The California Highway Commission had before it for consideration during the year 57 freeway projects



A formal public hearing, at which local citizens are urged to contribute information and ask questions, is part of every freeway route study conducted by Division of Highways engineers. Pictured is an official division hearing held for discussion of east-west and north-south freeways through Sacramento. Many informal meetings and map displays are also held.

and adopted the routings on 49 of these units, of which 39 involved a major relocation. Through this action of the commission, the freeway mileage was increased approximately 406 miles, resulting in a total of 5,609 miles of declared freeway as of June 30, 1961.

Freeway Agreements

The co-operation achieved with cities and counties in working out and concluding freeway agreements has been extremely satisfactory. Agreements for 148 freeway units were received for processing during the year. In some cases, original agreements were replaced by supplemental agreements which incorporated improved design standards or provided for changes in traffic patterns or local planning.

Interstate Highway System

A new statewide interstate highway deficiency study was completed during the year. In connection with this study, the advance planning section was responsible for obtaining prior approval from the U.S. Bureau of Public Roads on such factors as the route locations and basic design features including the number of traffic lanes, median and right-of-way widths, and the location of separation structures, interchanges, and frontage roads.

Advance planning is also responsible for obtaining bureau approval on the final locations of all routes on the Interstate Highway System, after adoption of each section by the California Highway Commission. At the end of the year, the locations for approximately 1,826 miles, about 84 percent of the Interstate System in California, had been approved. In addition, another 234 miles were being processed for submission to the bureau. The total mileage approved or under consideration at the end of the fiscal year is about 95 percent of the Interstate System in the State.

National Forest Highways

The Division of Highways acts jointly with the U.S. Bureau of Public Roads and the U.S. Forest Service in an annual improvement program on California roads designated as forest highway routes. The forest highway network in California covers approximately 2,465 miles, about 80 percent of which is on state highway routes. (A tabulation showing the status of forest highways appears in the statistical supplement.)

The California apportionment of forest highway funds for the 1960-61 fiscal year was $4,726,004. Including funds remaining from previous apportionments, the distribution of forest highway money in the State during the year was as follows: projects on state highways, $3,376,000; projects on county roads, $925,000; system surveys, $200,000.

The Bureau of Public Roads plans, designs, advertises and supervises the construction of federally financed forest highway projects. On projects on state highways, the Division of Highways works with the bureau in the planning and design phases and also purchases the required rights-of-way, including clearance of utilities and options on material sites.

PHOTOGRAMMETRIC MAPPING AND AERIAL PHOTOGRAPHY

Aerial photography is used in many ways for advance planning, and accounts for approximately 15 percent of photogrammetrics costs. Up-to-date aerial photography is a primary aid for route study.

Photogrammetric mapping of a reconnaissance type is used for route study of locations where earthwork quantities materially influence alignment and grade of possible alternate routes. For final location and design of virtually all highway facilities, large-scale, small-contour-interval mapping is used. Photogrammetric services are obtained under contract with private firms.

Following is a resume of expenditure for contracting during the fiscal year:

	Contracts	*Highway strip miles*	*Contract amount*
Contour mapping projects for design	45	396	$434,950
Contour mapping project for reconnaissance	8	151	69,794
Aerial photography contracts	12	—	26,994
Aerial photography contracts (blanket)	8	—	60,049
Stereoplotter rental contracts	7	—	9,056
Total			$600,843

Developments

The photogrammetric unit has acquired an electronic digital scaler for recording photogrammetric measurements directly on punch cards. The scaler is specifically designed for taking terrain cross-sections along a predetermined final centerline, automatically recording the information on the cards for earthwork quantity computation. The equipment attaches to a direct-project type of stereoplotter. Its use eliminates several intermediate steps associated with determination of the equivalent information from contour maps, and provides a direct link between photogrammetry and electronic computation.

Map Checking

A continuing program of photogrammetric analysis has proved to be an invaluable aid in obtaining accurate photogrammetric mapping by contract. The analysis provides information regarding adequacy of specifications, and isolates areas which warrant field checks to determine accuracies actually obtained. Extensive and costly field checking is thus largely eliminated.

About two-thirds of the total mapping mileage is reviewed by photogrammetric analysis. About 25 percent of the stereoscopic models thus reviewed are recommended for further field checks. This results in a major reduction in field checking requirements.

Geodetic Distance Measurement

During the fiscal year, the photogrammetric unit operated instruments for accurate geodetic distance measurement as a service to the districts.

A Model 4 Geodimeter has been used with outstanding success throughout the year. It is an electronic device which must be used at night. While assuring accurate surveys, the use of this instrument resulted in a savings of $60,000 during the year, as well as a 40 percent saving in time.

PROGRAMS AND BUDGETS

The Programs and Budgets Section makes projections on the availability of funds for highway purposes, establishes target figures to be used in planning, develops the statewide long-range planning program in co-operation with planning survey, prepares budget recommendations for consideration by the Highway Commission, maintains a constant check on the funds available for highway purposes in a fiscal year budget, recommends action on unbudgeted or minor improvement projects, and administers the annual buildings and plants program.

Budget and Revenue

The responsibility for preparing the annual budget for consideration by the Highway Commission rests with the Assistant State Highway Engineer, Planning. Engineering control of the state highway budget is performed under the supervision of the office engineer.

The division's revenues closely correspond to the volume and type of highway traffic. Long established and continuous records of this traffic throughout the State are used as a guide in estimating probable revenues for planning purposes. For budgeting, estimates of probable revenues are determined after consultation with other governmental departments and agencies such as the Departments of Finance and Motor Vehicles, and the Board of Equalization.

Buildings and Plants

During the fiscal year, district office building additions at Los Angeles, Redding, San Bernardino, and San Diego were completed. Construction was begun on the addition to the annex of the Public Works Building in Sacramento and plans for an annex building at the district office in San Francisco were completed. Plans were being developed for maintenance stations at 17 locations throughout the State.

DESIGN

The number of projects for which plans were prepared during the 1960-61 fiscal year was only two less than the record 414 projects set two years ago. More significant than the number of projects, however, is the increasing volume of plans. Approximately 7,300 sheets of plans were reviewed this fiscal year in order to ready the proj-

ects for advertising. This is 1,700 more than last year which reflects the increased volume of freeway construction.

Geometric Design

The geometric design unit processed 680 interchange and intersection designs during the year, as compared to 544 in the previous year. The exhibit maps for 148 freeway agreements were reviewed, and a total of 56 reports involving requests for new connections or separations on freeways were processed prior to presentation to the Highway Commission. A total of 526 bridge designs were reviewed with respect to geometric design features.

Structural Design

Typical sections representing approximately 200 proposed projects were processed by the structural design unit during 1960-61. This involved the review of all structural features, including materials sources, specifications, foundation conditions, subsurface drainage and slope design. Continued emphasis on these details during the early stages of design has resulted in more effective specifications and optimum utilization of available materials.

Continuing progress was made in the observation and compilation of factual data concerning the actual performance of past and current pavement designs. Features under observation include reinforced asphalt concrete and portland cement concrete pavements and thick bituminous pavement sections, variable joint arrangements in portland cement concrete pavements, cut slope and benching details and subsurface drainage installations.

Drainage and Co-operative Agreements

Freeway construction in urban areas has complicated many drainage problems. Urbanization has brought changes in drainage conditions which affect both existing and planned highways. This has increased the time spent in the review of drainage plans during the early design stages.

As in the past few years, drainage modifications and street rearrangements incidental to freeway construction have been handled by co-operative agreements. These co-operative efforts continue to pay increased benefits to both the highway and the local community.

During the early part of 1961, the actual processing of these agreements was made a function of the office engineer's section. Under the new procedure, the design department is continuing to review proposed co-operative agreements in the initial stage to determine the relative benefits and costs to each agency involved.

Research and Development in Design Methods

The drafting and plans section of the Planning Manual of Instructions was completed. The new manual establishes policies and standards and gives suggested procedures for the preparation of maps, plans and engineering drawings.

During the year, the electronic computation service for earthwork computation was improved. The new program is capable of evaluating hinge point and variable slope conditions as well as computing the proper hinge point, slope, and catch point values.

Erosion Control and Roadside Development

Since it is a highly specialized activity, the roadside development unit prepares all plans for functional planting and landscaping projects in Sacramento for the districts. During the 1960-61 fiscal year, plans and specifications for 31 projects were completed.

Certain items necessary for erosion control and landscape preparation can more economically be handled under the major construction contracts. All typical cross sections for all projects are reviewed with this in mind. The landscaping preparation includes such items as deep sterilization, spreading top soil and installing water lines or encasements for future water lines under roadways.



Large directional signs assist motorists in getting to their destinations, making freeway travel safer and more convenient. Over the years, directional sign systems for fast freeway traffic have been tremendously improved.

During the fiscal year, 36 functional planting or landscape projects valued at $5,002,800 were financed. The quantities involved in these projects exemplify the amount of work involved in the design preparation. Following is a list of the main items: 4,112 tons of straw, 132,375 pounds of seed, 572 tons of commercial fertilizer, 378,922 assorted trees and shrubs, 3,330,535 ground cover plants and cuttings.

TRAFFIC

In 1960, motor vehicle travel on the State Highway System exceeded 32 billion vehicle-miles, an increase of approximately 6.5 percent over 1959. Motor vehicle travel on rural state highways, based on the annual and monthly traffic counts, was estimated to be over 18 billion vehicle-miles, a slight increase over 1959.

In January 1961, a new statewide traffic census program began operation. A small force of full-time employees in each district, using portable automatic traffic counters, has replaced the approximately 6,000 part-time employees formerly required for the annual July traffic census. The new program provides an estimate of average daily traffic at some 10,000 locations on state highways, including cities. The machine counting program has reduced the annual cost of the census by about $300,000, about half the former cost, while more than doubling the number of locations counted.

Approximately $265,000 worth of new equipment has been purchased for the new program, including 296 recording counters. These counters produce punched tapes showing hourly volumes which are then fed into electric data-processing machines.

The 1960 fatality rate on rural state highways was 7.23 deaths per 100 million vehicle-miles of travel, which is the lowest fatality rate ever recorded on rural state highways in California.

The 1960 fatality rate of freeways, rural and urban combined, was 2.88 deaths per 100 million vehicle-miles of travel.

Geometric Standards and Traffic Service

Research continued during the year on several phases of freeway operations. As part of a nationwide study on ramp capacity being conducted by the Highway Research Board, field observations were taken at several locations in the Los Angeles and San Francisco Bay areas. A study of freeway traffic flow and causes of congestion was conducted on the Hollywood and Pasadena Freeways in Los Angeles. Another study was begun on traffic weaving between freeway on- and off-ramps.

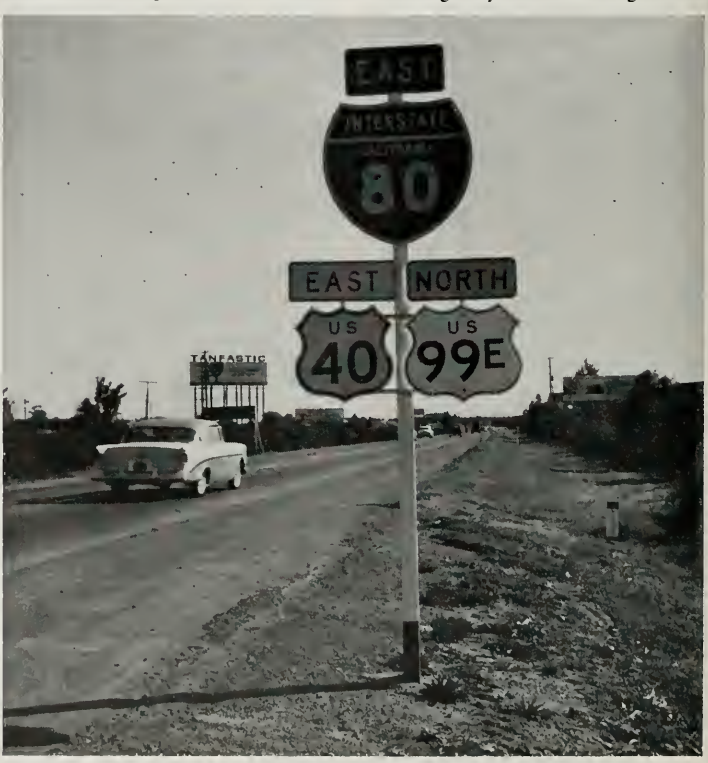
Origin and destination surveys were made at nine locations. These surveys are made to determine present traffic demands and to evaluate the relative service offered by alternate highway locations.

Traffic Signals and Illumination

Contract plans were completed for 154 new traffic signal installations and 119 existing signals to be modernized. Contract plans were also completed for 5,210 lighting standards and 628 illuminated traffic guide signs. The total estimated cost of the electrical work was $9,539,387, not including the cost of steel sign structures.

A total of 164 traffic reports reviewing conditions at approximately 307 intersections were made to determine the need for traffic signals or lighting.

Research projects under way included test installations of new types of vehicle detectors of the ultrasonic infrared and microphone transducer types. A contract was entered into with a private research firm to develop a nuclear energized self-luminous highway directional sign. This



These red, white and blue Interstate route shields are appearing in ever-increasing numbers as construction moves ahead on the State's 2,200 miles of Interstate freeway routes.

project is sponsored by the U.S. Bureau of Public Roads.

A traffic signal system was placed into operation near Sacramento consisting of six signals supervised by a master electronic computer and interconnected by microwave radio covering five miles of highway.

Standard plans for the electrical portions of the new truck weigh stations were developed, including new circuit designs for remote control and read-back of internally illuminated changeable message signs.

Traffic Regulation and Control

A statewide speed survey was conducted during October 1960 which included more than 50,000 individual observations at 146 selected locations on all types of highways. This was the first statewide speed survey since the 65-mile-per-hour maximum became effective January 1, 1960.

A comparison of the 1960 observed speed with previous surveys showed that, except for a leveling off of the average speed in 1958, speeds have risen at a fairly uniform rate since World War II.

The 1960 study showed an appreciably higher percentage of vehicles grouped in the middle speed ranges, 50 m.p.h. to 65 m.p.h. The 15 m.p.h. band between 50 m.p.h. and 65 m.p.h. accounted for 63.8 percent of all vehicles sampled and 67.9 percent of the passenger cars. The comparable figure for passenger cars on freeways showed 70.5 percent in this 15 m.p.h. range.

The average and critical speeds for all vehicles on all types of highways were 54.5 and 61.7 m.p.h., respectively. Comparable speeds of passenger cars were 55.9 and 62.7 m.p.h. for all types of highways, 57.4 and 63.9 m.p.h. for freeways, and 54.1 and 61.4 m.p.h. for two-lane roads. The critical speed, also called the 85 percentile speed, is the speed at or below which 85 percent of the traffic is moving.

As traffic control measures, after investigation and study, the following actions were taken:

- Established 359 speed limit zones on 321 miles of highways, and 43 other traffic regulating measures.
- Approved 115 city and county ordinances regulating traffic movement and parking on state highways.
- Approved requests for a total of 54,270 signs, consisting of 18,643 warning signs, 12,773 regulation signs, 16,000 guide signs, and 6,854 construction and other miscellaneous signs.

HIGHWAY PLANNING SURVEY

The planning survey department is divided into two main operating units, collateral engineering and statistical-financial. Engineering and economic investigations assigned to the Highway Planning Survey usually cover more than one district or are statewide in nature. Many such studies are undertaken at the request of the U.S. Bureau of Public Roads. Most studies are financed partly by federal funds amounting to a maximum 1½ percent of the total annual federal-aid apportionment to California.

Within the statistical unit there is an Electronic Data Processing and Machine Methodology Section which provides data processing and electronic computer services for planning survey and other departments, as well as for other divisions of the Department of Public Works.

The planning library is also attached to planning survey.

Collateral Engineering Studies

City street and county road needs to 1980 were compiled, audited, and summarized by the Division of Highways in accordance with the 1959 Senate Concurrent Resolution No. 62 and were then presented to the Senate Fact Finding Committee on Transportation and Public Utilities in a report dated August 1, 1960. The preparation of the S.C.R. 62 report was accomplished with the close cooperation between all the cities, counties, a 14-member Technical Advisory Committee, and the Division of Highways. This study covered approximately 70,000 miles of county roads and 30,000 miles of city streets.

The first revised estimate of the cost of completing the Interstate System was completed by the districts, reviewed and processed by planning survey, then submitted to the Bureau of Public Roads in September 1960. The estimate covered all of the 2,177 miles of interstate routes in California and included project cost estimates on all sections not completed to standards required to serve estimated 1975 traffic. The revised estimate is being used as the basis of allocating federal-aid interstate funds to the various states for the 1963-66 period.

At the request of the Senate Fact Finding Committee on Transportation and Public Utilities, estimates of cost for improvements on the State Highway System to 1980, "State Highway Inventory" (started in the prior fiscal year) were completed. These estimates were used by the committee and the 1961 Legislature in the revision of the statutes relating to the geographic distribution of the state highway construction funds as enacted in Senate Bill No. 1412.

Two special route studies were completed in the fall of 1960 for the State Legislature. Feasibility studies were made for a route from the Arizona state line near Yuma to Niland and to explore either improving the existing State Sign Route 41 or constructing the highway on new location between Paso Robles and Cambria.

A feasibility study of extending State Sign Route 8 from Mokelumne Hill, via West Point, to State Sign Route 88 was also completed and delivered to the Legislature.

The effect of state highway right-of-way acquisition on general assessments, which are a lien against real property levied by irrigation districts, was evaluated for the legal section. This study included estimated future right-of-way acquisitions through 1980 within irrigation and water storage districts.

The 1960 census disclosed a number of new urban areas (places of over 5,000 population). Maps of these new urban areas and maps of all other existing urban areas are being prepared to reflect the latest census data. These maps, which show urban area bound-



This new section of two-lane expressway on U. S. Highway 40 Alternate in Plumas County is typical of the modern two-lane highways which are now being built in many rural and mountain regions.

aries, are made for the Bureau of Public Roads and are used in the administration of federal-aid funds.

A study to prepare in graphical form the physical and traffic features of the existing traversable routes for the through Interstate routes was started in May 1961. This study is being made at the request of the Bureau of Public Roads.

Field surveys of existing geometrics, grades, passing sight distance restrictions, and some topographic features for the entire state highway system, were started in the fall of 1960.

The general plans or elements of a general plan for all cities and counties in the State were tabulated and summarized. The compilation of these data was a joint project of highway planning survey and city and cooperative projects of the division, the State Office of Planning of the Department of Finance, and the Bureau of Public Roads.

Statistical Studies

The methodology and data processing for the long-term Los Angeles Regional Transportation Study (LARTS) is a responsibility of the highway planning survey. Basic surveys for the collection of traffic data were completed in the last six months of 1960. The surveys included a home interview origin and destination survey for about 3,000 dwelling units, a "for hire" truck survey for about 2,500 trucks, a regular commercial truck mail survey for about 15,000 vehicles, and a roadside interview origin and destination survey for autos and trucks at 18 locations on the cordon of the 9,000 square-mile study area.

Data from these surveys and also data from a 350,000 post card subsample (from a 1959 survey carried out by the City of Los Angeles) are being processed and analyzed to develop complete 1960 survey data for all traffic in the study area. A land use inventory for each of about 2,500 traffic zones is also currently being made.

Analysis of all the survey data is providing general relationships as a basis for the development and testing of synthetic trip data to be obtained form a series of mathematical models. The models will utilize trip generation factors derived from the survey data, also land use data for the traffic zones, as a basis for projecting estimates of traffic in future years.

Other studies and services during the year included data collection phases of three special studies carried out primarily for the Bureau of Public Roads—the annual truck weight survey, a passenger car size classification and occupancy study, and the completion of a fuel consumption survey of Division of Highway personnel.

A method was developed for use of the computer to obtain extreme value data in the analysis (information on infrequent occurrences) of rainfall intensities, stream discharge data, and other similar studies. The development of special methods for handling complex metropolitan traffic study routing problems by computer was continued.

Electronic Computer Service

The major programs in the engineering computations field are earthwork computations, traverse computations, and profile grade and grid computations. The use of these programs has greatly increased since they were first introduced in 1956.

The data processing unit is a well-balanced system consisting of key punches, sorters, collators, gang punches, tabulators, and computers. Two new computer units have greatly increased computing capacity in the past year.

Efficient utilization of the capacities of the system requires an understanding of the processes and problems of the department, as well as a capable programming staff. To study problems and possible applications an advisory team has been established. Its function includes co-ordination of the activities of the computing unit to best meet the needs of headquarters and the districts. The team also studies new equipment on the market and new procedures to keep abreast of technological advances.

Financial Studies

Three continuing studies have been carried on in co-operation with the Bureau of Public Roads:

The annual local road and street finance report summarizes the highway transactions of cities, counties, and special districts.

Recording of basic data in the road life and pavement cost study has been continued, and one set of tables of pavement construction and retirement was submitted to the Bureau of Public Roads. Some 12,000 miles of rural state highways are represented in the study.

Improvements were made in the Status of Highways (State Highway Log) and the Federal-Aid Log. Annual mileage reports were compiled for the Bureau of Public Roads and tabulations were provided for state use.

• Bridges

• *The Bridge Department of the Division of Highways is under the administration of the Assistant State Highway Engineer—Bridges and is responsible for the design, construction and maintenance of all bridges and structures on the state highway system.*

A branch office of the Bridge Department is located in Los Angeles to maintain liaison with southern area districts, perform planning functions and supervise construction and maintenance of structures within these districts. All other functions, including all design work, are handled at the headquarters in Sacramento.

For purposes of administration, the department is divided into five sections —Planning, Operations, Special Studies, Office, and Special Projects. The maintenance and operation of state-owned toll bridges are also under the administration of the Assistant State Highway Engineer—Bridges.

The 1960-61 state highway construction budget included $109,836,000 worth of structure work in 86 projects, a 4 percent increase over the preceding year. Most of this was new construction, although some was for widening or strengthening existing structures. Miscellaneous projects including flood damage repair, federal aid secondary projects, maintenance, and work for other agencies financed and contracted during the fiscal year amounted to $22,975,000 for a grand total of $132,811,000.

BRIDGE PLANNING

Problems associated with freeway planning through metropolitan areas received special study emphasis. Elevated and depressed alternatives were studied for portions of the freeway system in Sacramento and for the U.S. 101 freeway through Santa Barbara. The feasibility of a two-mile freeway tunnel on U.S. 66 in Beverly Hills was explored. As part of the planning of freeways in the Fresno metropolitan area, 226 different studies and cost estimates of separation structures were made.

The economic effects of fixed bridges over navigable rivers were examined in a report by the U.S. Corps of Engineers after its study of the proposed Sacramento River R Street Bridge on the West Side Freeway (Route 238). While the report contained a clearance recommendation for this crossing only, it also carried economic data to be used later in establishing clearances for six other future bridges between Rio Vista and Chico Landing. The Corps of Engineers is conducting a navigation clearance study for the Route 238 crossing of the Stockton Upper Channel, just above the deep water turning basin. The Advance Planning Section supplied bridge and highway cost data for these studies.

Also investigated during the year were an offshore viaduct for U.S. 101 Alternate near Santa Monica; the feasibility of transporting 400,000-pound missile boosters across bridges; and the co-ordination of the Bridge Department's participation in pre-

Construction crews expect to complete work in 1962 on this new West Branch Feather River Bridge which is being built as part of the relocation of US 40 Alternate around the future Oroville Dam and reservoir. Highway traffic will use the top deck, and the lower deck will carry railroad tracks. — Department of Water Resources Photo



paring of the interstate highway cost estimates and the state highway inventory.

The 526 preliminary bridge design reports completed in the year represented an increase of 24 percent over the previous year and approached the all-time high of 537 reached in 1956-57. Field crews from Sacramento headquarters investigated 315 bridge sites.

Architectural Bridge Design

To show the interested public how freeway structures will look, 70 architectural renderings, 20 photographic retouches and eight models were produced. Many of these were displayed at public meetings or reproduced in newspapers; some were used as exhibits in legal proceedings. These devices were used to show elements of early California style architecture proposed for a freeway viaduct in Santa Barbara and to illustrate the planned landscape treatment of major interchanges in the Monterey area.

The model of a proposed low level bridge across Emerald Bay, which was exhibited at a joint meeting of the California Highway Commission and California Park Commission, had a removable section so that different bridge styles could be viewed in proper setting.

Foundation Section

During the past year, foundations were constructed or nearly completed on several large structures for which foundation studies had been made including the West Branch Feather River Bridge, Benicia-Martinez Bridge and the Webster Street Tube.

The exploration methods utilized in making these studies were seismic, deep water drilling requiring the use of a drilling tower, shallow water drilling from a barge, and surface geological studies.

Practically all foundation supports for these three structures are now in place, and field construction is being checked against predicted foundation conditions.

This year 510 bridge structures and 120 retaining walls, 100 feet to one mile in length, were investigated.



The Randolph Collier Tunnel is being drilled through the mountains at Hazelview Summit on U. S. Highway 199 in Del Norte County. The tunnel and approaches will eliminate the present steep and sharply curving highway.

Design

The most interesting structure for which the design was completed during the fiscal year was the Yolo Causeway across the Sacramento River overflow on U.S. 40 near Sacramento. The $4,800,000 crossing consists of two parallel bridges, each having a total length of 11,680 feet. The two separate bridge sections are 2,880 feet and 8,800 feet long, separated by a one-mile fill. The total deck area, 1,176,000 square feet, is very close to the largest ever placed under one contract and by far the largest in the Central Valley area.

The bridge is remarkable for its low cost. The substructure cost 70 cents per square foot and the superstructure cost $3.10 per square foot. The overall cost of $3.80 per square foot of deck is the lowest since the depression days.

The contractor was permitted the choice of alternative designs consisting of cast-in-place reinforced concrete, precast reinforced concrete and three different types of precast-prestressed construction. The contractor selected the precast-prestressed "M" section which will require 5,256 units each 40 feet long and five feet eight inches wide.

Plans were completed during the year for 43 structures on the San Diego Freeway in Los Angeles County; for the $1,000,000 bridge across the Eel River on US 101 (Redwood Highway) at Myers Flat; and for the last of the 69 structures on the US 40 (Interstate 80) freeway between Weimar and the Nevada line. The total cost of all 69 bridges on the high Sierra freeway will be approximately $11,000,000.

Bridge Construction Costs

Bridge construction costs, as measured by the Bridge Department Construction Cost Index (base year 1939-1940=100), closed the 1959-60 fiscal year with a value of 244 and then moved to successive values of 257, 249, 259, and 261 for the four quarters of fiscal year 1960-61.

BRIDGE OPERATIONS

Twenty-six bridge contracts were completed during the year at an approximate cost of $13,117,000 which includes $2,581,000 in road work. In the same period, approximately $28,009,000 in structure work was completed in 51 district contracts for an overall total of $41,126,000 on 77 projects involving 252 structures. This compares with 397 structures constructed in the preceding fiscal year. This reduction in number as well as expenditure reflects back to very limited advertising of work in the fall of 1959 and spring of 1960 under temporary federal financing restrictions. At the end of the fiscal year, 185 projects were under construction involving structures amounting to $266,905,000. This included funds for the Benicia-Martinez Bridge, the West Branch of Feather River Bridge and the newly started San Pedro-Terminal Island Toll Bridge, as well as for projects financed from various fiscal year budgets and work on federal-aid secondary projects.

Contracts were approved for two major tunnels on the state highway system: the Caldecott Tunnel on State Sign Route 24 between Oakland and Walnut Creek, and the Hazelview Summit (Randolph Collier) Tunnel approximately 2½ miles from the California-Oregon line on US 199.

Metropolitan Area Freeway Structures

In San Francisco construction started on the Southern Freeway between Milton Street and the James Lick Memorial (Bayshore) Freeway along Alemany Boulevard. The project includes five permanent bridges and one temporary structure, costing an estimated $1,026,000, together with 10 retaining walls at a cost of $1,190,000.

In San Jose, nine bridges and a pumping installation, costing $1,275,000 were completed at the Nimitz-Bayshore Freeway Interchange. Two Bayshore Freeway widening projects, between Mountain View and San Jose, include 16 bridges and one pumphouse at a total estimated cost of $2,139,000.

The third and final stage of the Greenbrae Interchange project on US 101 in Marin County is nearing completion. North of San Rafael on US 101, work started on Miller Creek Road Overcrossing.

By the end of the year, construction was well along on four large contracts, including 25 structures, on the MacArthur Freeway (US 50) in Oakland. About $6,200,000 in structure work was done on this section during the year. Concrete box-girder spans are being used entirely on this freeway, resulting in a pleasant conformity of appearance and in construction economies.

On the various freeways in the Los Angeles area, 137 structures were completed and 372 additional structures were under construction at the end of the year.

The interchange linking the Santa Ana, Golden State, Santa Monica, and future Pomona Freeways, comprising 33 structures, was opened to traffic.

Four contracts on the Santa Monica Freeway, totaling 4.8 miles of the viaduct from the west end of the Los Angeles River Bridge to Vermont Avenue, are well under way, and the section between the Los Angeles River and the Harbor Freeway should be completed in the next year. The total low bid average of the four contracts for structure items for 3,924,500 square feet of viaduct was approximately $25,313,000—or an average of $6.45 per square foot. This very low cost may be attributed to a high degree of standardization, dupli-



An important element in the future freeway system for metropolitan San Diego will be this four-level interchange which is now under construction.

cation and very competitive bidding. The most significant factor in this low cost is the average substructure cost of only $1.20 per square foot achieved through the use of 36- and 48-inch column-piles. A column-pile is a round reinforced concrete column integral with a single cast-in-drilled-hole pile the same diameter as the column.

In the San Bernardino-Riverside area, 14 structures were completed on the Riverside Freeway, and 87 structures are under construction on various freeways and highways in the area.

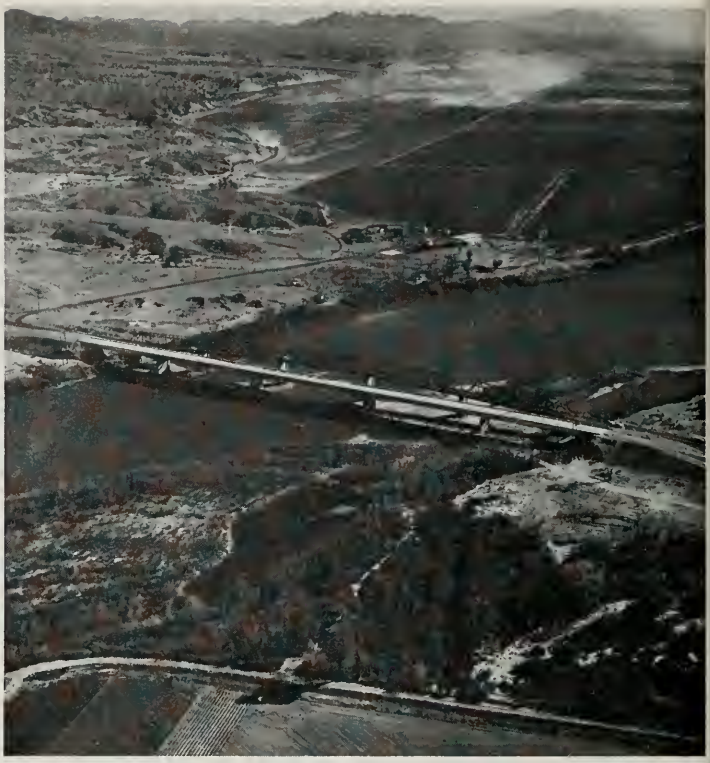
Thirteen structures were completed in the San Diego area, and 69 structures are under construction. Work is well under way on the four-level interchange structure at the junction of the San Diego and the Cabrillo Freeways.

Other Major Projects

Work on the Webster Street Tube under the Oakland Inner Harbor between Oakland and Alameda progressed to the half-way point during 1961.

The total cost of the entire tube project exceeds $20,000,000. The new tube parallels the present Posey Tube, which is one block east. After the new tube is opened to traffic in the fall of 1962, the Posey Tube will be closed for improvements. The two tubes will go into operation early in 1963 as a divided highway with each carrying two lanes of one-way traffic.

At the end of the year, work was approximately 75 percent complete on the combination highway and railroad bridge across the west branch of the Feather River in Butte County. This bridge will carry four lanes of highway traffic on the top deck and a single railroad track on the bottom deck. The project is part of the relocation of the Feather River Highway (US 40 Alternate) and the Western Pacific Railroad around the proposed Oroville Dam and Reservoir. The substructure was completed in the fall of 1960 and structural steel erection was completed in late summer of 1961. The bridge should be completed and opened to highway traffic in the early spring of 1962. Railroad traffic is planned to start on a trial basis during July 1962, after Western Pacific Railroad lays ballast and track.



California and Arizona co-operated in the construction of this new bridge over the Colorado River near Blythe. Photo looks southeasterly into the neighboring state.

A bridge across the Colorado River on US 60-70 near Ehrenberg was completed. The State of Arizona and State of California shared in its cost on an equal basis.

Federal Aid Secondary Bridges

The Bridge Department continued to advise and assist the counties in all matters pertaining to bridges on county roads included in the Federal Aid Secondary System.

Contracts were awarded for the construction of 15 bridges at a total contract cost of more than $2,000,000. Eleven additional bridges, two highway separation structures and one railroad overhead, having a total structure cost of $700,000, were included in road contracts. County engineering departments designed and prepared plans for structures in 16 of the 21 FAS projects that included bridge construction, and furnished construction engineering on all but two of the projects.

Bridge Maintenance

Periodic field investigations were made of the 6,705 bridges of the State Highway System by the bridge maintenance section. Reports and plans were prepared for needed repairs and minor improvements. Capacity ratings for all structures were kept up-to-date. The replacement of structurally deficient bridges was scheduled.

Bridge maintenance work and repairs, not including painting, cost approximately $450,000. A total of $205,000 in construction funds financed other improvements and repairs.



This photograph, taken in May, 1961, shows the pier construction which had been completed and initial superstructure work underway on the Benicia-Martinez Toll Bridge across the Carquinez Strait. The existing lift-span railroad bridge is in the background.

Two timber bridges were destroyed by fire—one west of Blythe on US 60 and the other east of Amboy on US 66. Local detours were provided at these sites pending construction of new bridges.

Engineering investigations were made as required by law and at the request of the local authorities on 40 city and county bridges, for the purpose of establishing their load capacity. Fifteen public hearings were held to post 21 of these bridges for less than legal loads.

New construction made it possible to drop four structures from the list of bridges posted for reduced speeds. On June 30, 1961, there were three bridges and three ferry crossings on the State Highway System which were posted for reduced loads and 34 posted for reduced speed.

The accompanying list of bridges shows all structures of the state highway system. Structures having assorted types and lengths of spans are shown by number and lengths on the basis of the main span, but areas have been segregated and appear under the various type headings. Areas of bridges are based upon the clear width of roadway between curbs plus the clear sidewalk width.

Bridge Maintenance Painting

Five maintenance painting contracts involving nine separate structures were completed, using the new green colors. In addition, three bridges on US 40 near Davis were finished in green. Total allotment for the maintenance painting contracts was about $196,000. Twenty-seven new bridges were also painted under construction contracts. Painting work on the Benicia-Martinez Bridge across Carquinez Strait and the West Branch Feather River Bridge started during the year.

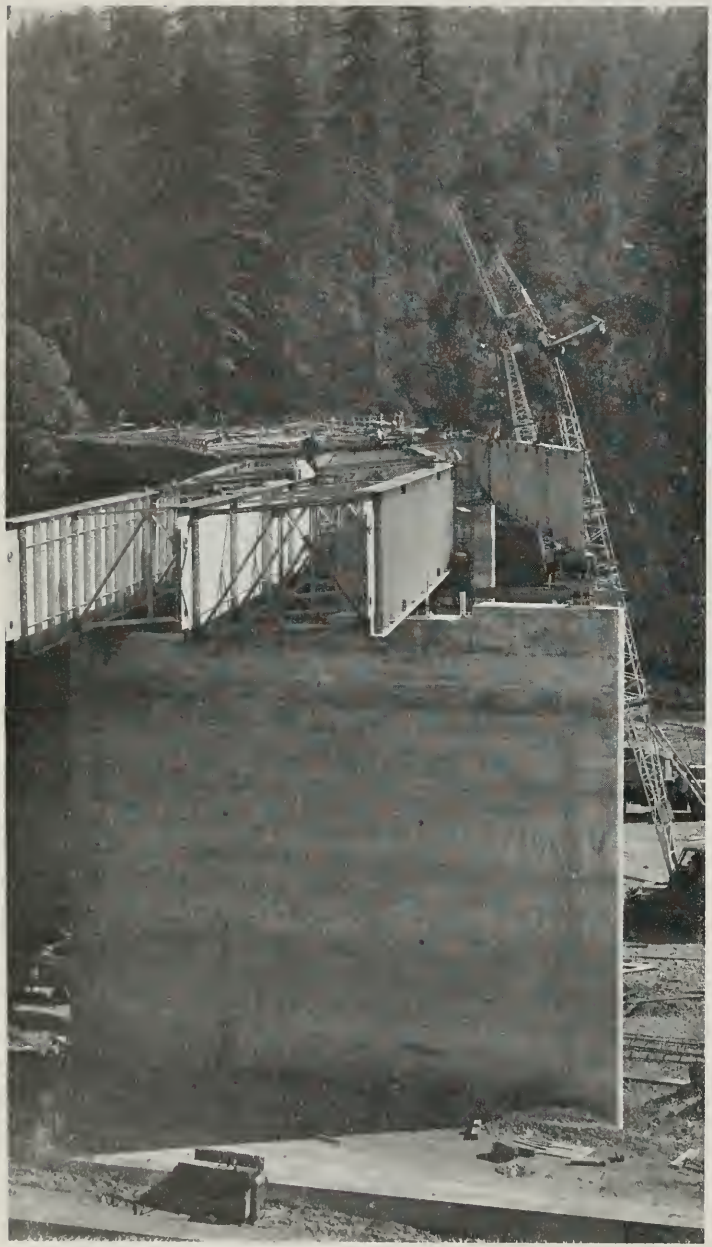
A comparatively new device, which propels small metal spheres at high velocity at the steel surface, is being used in the fabricator's shop to clean much of the steel for the Benicia-Martinez Bridge. The machine eliminates labor in the cleaning process. There is increased use of airless spray methods which reduces to minimum the paint loss through spraying.

Compilation of a more complete record of the humidity range throughout the State has been undertaken to provide for more accurate forecast of the needs in each area and to assist in establishing specifications to meet these requirements.

Special Studies

Activity in structural research increased with the completion of the field phase of testing on the Box Girder Research Project in Oakland. This project, to determine structural characteristics of a concrete box girder bridge, is a joint effort of the Division of Highways and the University of California.

During the past five years, the Bridge Department has participated actively in the development and use of electronic-computed and data processing services. In collaboration with the Planning Survey Department, a library of computer programs has been developed to serve needs peculiar to bridge design and construction. The computor programs relate to structural analysis and design, and materials quantity calculations. They include services for composite steel-concrete girder design, prestressed concrete girder design, concrete column analysis, moment distribution,



Construction is in progress on this new freeway bridge over the South Fork Eel River on U.S. Highway 101 in Humboldt County.

and layout problems involving horizontal and vertical alignment of bridges. Studies in the fields of hydrology, hydraulics, drainage, bridge pier scour and bank protection were continued. The new publication, "Bank and Shore Protection in California Highway Practice" was assembled and edited.

An engineering library on river hydraulics and bridge engineering is maintained.

BRIDGE OFFICE ENGINEERING

Bridge office engineering includes the administration and management of the various service units.

A major function is the negotiation and preparation of maintenance and construction agreements with railroads in connection with construction of railroad grade crossings and grade separations.

Railroad Grade Crossings

Construction was started, underway, or completed on 57 highway projects requiring negotiations with railroads which involved right of way encroachments, installation of additional crossing protection, or construction, alteration or abandonment of grade crossings. At the end of the year, negotiations were in progress for 23 additional projects. Thirty-two projects involving upgrading of crossing protection were completed or underway. On federal-aid secondary routes, negotiations were underway or completed on 36 projects with railroad involvement.

At the beginning of the year, there were 50 railroad-highway grade separation structures under contract. Seventeen grade separation structures were completed during the year. The railroads, in accordance with regulations, contributed a total of $56,000 toward the cost of two of the completed structures. Contracts were awarded for an additional 37 structures.

Railroads will contribute to the construction costs of four separation structures for which contracts were awarded during the year.

$5 Million Grade Crossing Fund

The Public Utilities Commission issued the 1960 priority list containing 18 proposed separation structure projects to eliminate railroad grade crossings on county roads and city streets. In accordance with state law, $5,000,000 in state highway funds is set aside by the Highway Commission each year to pay half the cost of each separation project after deducting the railroad contribution.

As of June 30, 1961, allocations in the amount of $4,771,000 had been made by the Highway Commission from the 1960-61 fiscal year funds for 8 of the 18 projects on the PUC list. list.

SPECIAL PROJECTS

Carquinez and Benicia-Martinez Bridges

The new Benicia-Martinez Bridge is now "out of the water" from a construction standpoint, and the last major phase of construction has been started. Steel truss span erection was started in May, 1961, and the contractor's excellent progress indicates that the bridge may be ready to open to traffic early next summer.

The structure is financed by the sale of revenue bonds which were authorized on October 4, 1955, by the California Toll Bridge Authority in a resolution authorizing the creation of an issue not to exceed $80,000,000. Since this authorization, $46,000,000 in revenue bonds have been sold for the construction of the new, parallel Carquinez Bridge, completed in 1958. The revenues from both structures are to be used jointly to retire the total bond issue. Traffic across the Carquinez Bridge continues to increase. When the Benicia-Martinez Bridge is opened, the added toll revenue should provide for bond retirement earlier than was first anticipated.

Construction Moving Along

Construction on the Benicia-Martinez Bridge has moved along quite rapidly the past year. All of the foundation piers were completed and made ready to receive the steel superstructure.

The steel girder approach spans on the Martinez side were erected, and the concrete roadway deck was placed. Erection of the steel truss spans was started in May on the Martinez side.

The bridge is 6,215 feet long. There are nine deep-water piers supported on six foot diameter concrete-filled caissons extending into bedrock about 130 feet below the water surface. The main spans are steel trusses, 330 to 528 feet long. The approach spans are steel girders supported on concrete piers.

In addition to the substructure and superstructure contracts, there were five additional contracts under way as a part of the Benicia-Martinez Toll Bridge Project—the Solano County freeway approach, the Benicia Arsenal right-of-way clearance, the Contra Costa County freeway approach, the widening of Escobar Street in Martinez, and the installation of toll collection equipment.

BRIDGES ON THE STATE HIGHWAY SYSTEM SEGREGATED AS TO NUMBER, LENGTH AND AREA BY STRUCTURE TYPE, AS OF JUNE 30, 1961

	Number		Length (feet)	Area (square feet)
Structure type	*1961*	*1960*	*1961*	*1961*
Concrete arch	240	242	39,545	892,823
Concrete girder	1,752	1,649	363,015	21,476,139
Concrete slab	2,278	2,234	137,654	5,711,087
Masonry arch	33	33	962	21,735
Subtotal concrete and masonry	4,303	4,158	541,176	28,101,784
Steel arch	5	5	1,708	26,760
Steel plate girder	339	322	178,815	6,004,254
Steel stringer	285	287	62,328	3,718,707
Steel deck truss	30	29	24,609	1,198,893
Steel pony truss	32	34	10,813	179,674
Steel through truss	69	69	116,965	1,512,874
Suspension	2	2	15,097	884,145
CMP multiplate and arch	67	65	1,365	45,742
Subtotal steel	829	813	411,700	13,571,049
Timber arch	3	3	859	6,352
Timber stringer	622	669	45,310	2,229,722
Timber deck truss	10	10	2,753	39,429
Timber pony truss	1	3	127	2,899
Timber through truss	1	1	79	1,722
Subtotal timber	637	686	49,128	2,280,124
Total bridges	5,769	5,657	1,002,004 (190 miles)	43,952,957 (1,009 acres)
Underpasses	186	185	—	—
Overheads *	223	215	—	—
Combined bridges and overheads *	46	42	—	—
State highway separations *	249	214	—	—
Road undercrossings *	823	738	—	—
Road overcrossings	632	561	—	—
Pedestrian undercrossings *	155	158	—	—
Pedestrian overcrossings	71	67	—	—
Cattlepasses *	84	92	—	—
Tunnels	20	20	14,199	—
Retaining walls	6	6	4,707	—
Miscellaneous	21	22	1,909	20,266
Total structures	6,705	6,518	1,022,819	43,973,223
Drainage pumping plants	180	178	—	—
Railroad grade crossings	682	720	—	—

* Separations so noted are listed under structure type above.

NOTE: One underpass, 16 overheads, one tunnel, and one bridge and overhead also serve as state highway separations.

San Pedro-Terminal Island Bridge

On February 28, 1961, the California Toll Bridge Authority authorized a bond issue not exceeding $7,000,000 toward the construction of the San Pedro-Terminal Island Bridge. On April 11, 1961, $5,000,000 of this issue was sold.

Bids were received March 22, 1961, for work on the substructure and Guy F. Atkinson was low bidder at $2,-634,040. The contract was approved and work on the substructure was started May 1, 1961.

On March 23, 1961, bids were received for the steel superstructure. Kaiser Steel Corporation was the successful low bidder at $11,374,000. The contract was approved and work started on May 2, 1961.

The San Pedro-Terminal Island Bridge will be the first major suspension bridge in Southern California. It will be 6,010 feet long, spanning the waters of Los Angeles Harbor. The suspension portion will have a central span 1,500 feet long with two side spans each 506 feet long. The remainder of the structure will consist of steel girder approach spans varying in lengths from 150-220 feet.

The bridge is scheduled for opening to traffic the later part of September, 1963.

STATE-OWNED TOLL BRIDGES

San Francisco-Oakland Bay Bridge

A record total of 39,842,155 vehicles crossed the San Francisco-Oakland Bay Bridge during the year. This is a gain of 3.6 percent over the previous year. The daily average for the year was 109,156 vehicles.

The month of highest average daily traffic was June, 1961, with a new high record of 114,401 vehicles per day. The previous high was in June, 1960, when the daily average was 110,411 vehicles. New high figures for a single day's traffic were established on three successive occasions during the fiscal year—first on August 26, 1960, with 127,803 vehicles, then on May 12, 1961, with 129,140 vehicles, and finally on June 16, 1961, with 131,826 vehicles. The highest record for the preceding year was 126,865 vehicles on September 4, 1959.

The revenue derived from vehicular tolls, rent, and miscellaneous services, exclusive of interest, was $12,-094,511. This was an increase of $201,-520 over comparable revenue of the previous year.

A contract for reconstruction of the eastbound toll plaza was partly completed. This work, when completed, will provide 17 modern toll booths, and all tolls will be collected from the driver's side of the vehicle.

Work was also under way at the end of the year on major repairs to the timber fenders which protect the bridge piers in the principal navigation channels.

The Division of Architecture completed a modern installation to provide a workshop, lunchroom, and cleanup facilities for the West Bay painters.

The Division of San Francisco Bay Toll Crossings continued work on the $35,000,000 remodeling which will convert the bridge for five lanes of one-way traffic on each deck.

The total amount expended during the year on general paint maintenance was $784,018.36.

San Mateo-Hayward and Dumbarton Bridges

The total traffic on the San Mateo-Hayward Bridge for the year was 3,-646,253 vehicles, and the toll revenue amounted to $1,395,183.05. For the same period, the traffic on Dumbarton Bridge was 2,477,290 vehicles, with a corresponding toll revenue of $952,765.75.

The temporary toll plaza facility at Dumbarton Bridge was further improved by the addition of a protective canopy structure over the toll lanes. At the end of the year, additional improvements to the temporary plaza were under way to provide for a fourth toll lane and the installation of electronic toll collection equipment. The fourth lane will make available two traffic lanes in both directions. This improvement was made necessary by steadily increasing traffic, plus the need for additional time to permit an embankment to settle at the site of the permanent toll plaza.

Approaches Improved

Dumbarton approaches were improved to provide two 12-foot lanes with 8-foot shoulders in place of the former 13-foot lanes and 3-foot shoulders.

The Division of San Francisco Bay Toll Crossings continued operations which will ultimately result in expanding the traffic capacity of the San Mateo-Hayward Bridge. During the year, work started on construction of embankments at the future toll plaza site, and bids were called for on construction and reconstruction of the easterly portion of the trestle structure.

The lift span operation was continued on both bridges as required by federal law. During the year, there were 2,201 lifts of the San Mateo-Hayward Bridge and 1,229 lifts of the Dumbarton Bridge.

Maintenance costs of the San Mateo-Hayward and Dumbarton Bridges were paid from the State Highway Fund, in accordance with state law and the bond resolution.

All outstanding bonds on both bridges were called during the fiscal year. Tolls were continued, in accordance with law, to provide funds for improvement and enlargement of the San Mateo-Hayward Bridge.

Richmond-San Rafael and Carquinez Bridges

The traffic total on the Richmond-San Rafael Bridge during the year was 3,466,958 vehicles, and revenue was $2,912,458.50. These figures represent increases of 7.71 percent and 5.87 percent, respectively, over the preceding year.

A total of 13,428,582 vehicles used the Carquinez Bridges during the year, and $4,578,444.50 was collected. This was a traffic increase of 8.98 percent over the previous year, and a revenue gain of 5.33 percent.

A contract to stabilize hinges on the Carquinez interchange structure was completed during April, 1961. This work involved placing tie rods diagonally across the hinges to reduce transverse movement. Rods were placed across the three hinges where the bridge is on a curve and the movement was the greatest.

25th Birthday



On November 12, 1961, the San Francisco-Oakland Bay Bridge celebrated her silver anniversary, marking 25 years of traffic service which has long since earned for her the title of "Main Street of the Bay Area."

There can be little doubt about her right to the title. On or about her 25th birthday the 650,000,000th vehicle crossed over one of her two levels of decks bound either from the East Bay to San Francisco or the other way around.

Now, that's quite a few cars. It's enough to extend bumper to bumper from here to the moon nine and a half times. Not only has she born the brunt of commuter traffic across the bay, she is also the western end of two trancontinental highways, US 40 and US 50. On an average day she carries 110,000 vehicles, on peak days as many as 133,000. When current reconstruction work is completed, she will be able to carry many more in five lanes (one way) on each deck.

Yes, the 25-year-old matron has come of age and then some. What's more, after all this time her statistics are still impressive.

Hands down, she's still the longest high-level bridge in the world—eight and a quarter miles.

The top of her highest tower is 519 feet above the water; her deepest pier is 242 feet below water level.

The length of all her cable wire totals 70,000 miles.

The concrete and reinforcing steel in her were enough to rebuild all the large office buildings in downtown San Francisco at the time of her construction.

The timber used during her construction was enough to building 3,000 five-room houses, enough for a town of 15,000 people.

Statistics aside, one thing is certain. After all these years it is still difficult for a Californian and especially a Bay area resident to repress a feeling of pride when he gazes upon the mighty structure across the bay which still holds a place among the wonders of the modern world.

PHOTO ABOVE—A night shot of the Bay Bridge looking west toward the San Francisco skyline from the Treasure Island Turnoff on Yerba Buena Island. PHOTO BELOW—Perhaps more typical of the Bay Bridge in the memory of most Californians is this photo taken some years ago while some of the ferries were still plying the Bay. San Francisco is in the background.



Personnel & Information

- *The functions of personnel, training, safety, audio-visual, and public information are grouped administratively under the direction of the engineer in charge of Personnel and Public Information*

PERSONNEL

Because of the expanded highway program, the total personnel of the division increased from 14,057 to 15,421 during the year. Most of this was in the engineering staff, with an approximate increase of 960 for a total of 7,908. At year's end, there were also 3,845 maintenance employees, 552 right-of-way agents, 468 in equipment maintenance, and 2,648 employees in administrative service, accounting, and clerical classes.

Position Classification

In order to meet recruitment needs or changing job conditions, a number of new classifications or revised class specifications were adopted. Primary among these were nonprofessional engineering classes at the assistant level in the highway, bridge, and physical testing series. In conjunction with this action, qualifications for other engineering classes were amended to require engineering training or possession of an engineer-in-training certificate to promote the utilization of professional engineers.

Other classifications, such as toll collectors, right-of-way agent series, communications, field office assistants, and accountants have been reviewed for necessary changes. Pertinent data on salary needs have been submitted to the State Personnel Board where appropriate. Examination needs and procedures have been reviewed, with greater participation by division staff in some of the examination processes.

During the last part of the year, the Personnel Office participated with State Personnel Board staff in a classification audit of the positions in the divisions. A sampling of approximately 20 percent of the jobs was made. This audit will result in changes and updating of a number of the classifications used by the division.

Personnel Management and Recruiting

In conjunction with the classification audit, a personnel management inventory was also conducted by a sampling of employee opinion on such subjects as supervision, communications, working conditions, sick leave and vacation, and overtime policies.

During the year a new performance appraisal and employee development program was installed, tailored to meet the division's needs. All supervisors were trained in this process, and all employees were given information on their expected participation in the program.

The division has continued to participate in the Personnel Board nationwide recruitment program for junior civil engineers. As a result of these tours, approximately 150 appointments

A flagman hands out a leaflet which explains the reasons for a traffic delay on US 466. The Division of Highways has found that motorists appreciate this courtesy when detours cannot be provided and long delays are necessary. Anticipated delays are always publicized ahead of time, and signs are posted to inform motorists of closing schedules.



were made during the fiscal year. This number, however, was not sufficient to meet the needs created by increased work load and normal turnover. Additional recruiting efforts, both in California and on a nationwide scale, are being undertaken.

Statistics

For some time the Personnel Department has been utilizing the services of the electronic data processing section for record keeping purposes. This program is now being expanded, and it is expected that additional personnel records will be automated.

During the year, 27 employees were dismissed (five with permanent status, 22 with temporary status). Eight were rejected during the probationary period. There were 28 disciplinary suspensions and one disciplinary demotion.

A total of 111 employees retired, making a total of 1,641 who have retired from the division. One hundred 25-year awards were given with appropriate ceremonies, making a total of 1,984 since the program started. During the year, 65 visitors from 17 foreign countries were given training and information.

TRAINING ACTIVITIES

The Division of Highways training program encompasses activities designed to meet agency needs by developing employee and managerial proficiency and talent.

During the year there were 174,100 man-hours of training in the major areas of orientation, supervision and management, technical and professional, safety, maintenance, and clerical. Most training was on state time, but there was a substantial amount on the employees' own time. There were 27,002 hours of instructors' time.

Supervision and Management

A new employee appraisal and development plan was placed in operation. Under the plan, the determination of agency training needs is co-ordinated with the supervisory appraisal of each employee's performance.

Supervisors and employees analyze the employee's performance and recommend the development activities necessary to gain maximum use of the employee's potential. All managers and supervisors participated in small-group training sessions covering the new program.

A 70-hour supervisory course for first-line supervisors in engineering, right-of-way, and administration was developed and tested. It includes planned home study, action assignments, and workshop discussion meetings. A 16-hour supervisory training course has also been developed and installed for supervisors of clerical personnel.

Division personnel took part in the annual interagency management conference and in the regional middle management conferences. Individual managers also participated in special interagency management development courses.

Total supervisory and management training time was 18,166 man-hours.

Professional and Technical

Professional and technical training amounted to 100,742 man-hours in both district- and headquarters-originated programs. Training programs covered such subjects as right-of-way negotiations, drainage design in high-



Training sessions on "Procedures, Testing Methods and Use of Materials for Highway Purposes" were held during the year. The Division of Highways conducts extensive training programs for employees at all levels.

way practice, portland cement concrete paving, automotive electricity, and right-of-way engineering.

Formal training was also used to help establish new agency programs in fields such as construction job accounting, and machine accounting methods.

The compulsory two-year rotation program for junior civil engineers continued, with 644 engineers participating. In some instances, employees were sent to educational institutions for special training.

Employees also participated in special courses on real estate appraisal, electronic data processing, fundamentals of traffic engineering, vehicle maintenance, motor vehicle fleet supervision and electric welding procedure.

EMPLOYEE SAFETY

The statewide accident prevention program of the Division of Highways is designed to develop accident prevention methods, to obtain useful statistical information, to prevent industrial accidents and injuries, and prevent motor vehicle accidents where state-owned equipment may be involved.

Full-time employees are designated as safety supervisors in 10 districts. The remaining district has an employee assigned to this function for one-half of his time. The Bridge Department, State-owned Toll Bridges, Service and Supply, Materials and Research and Equipment Departments also have safety supervisors on a part-time basis.

Safety supervisors make investigations and recommend safety programs and protective devices. They also check on compliance with regulations relative to safety, health, and fire prevention. They investigate accidents and advise employees on accident prevention.

Each district and major department has a safety committee, mostly composed of staff officials. The committee meets monthly and reviews accident reports to determine appropriate action to prevent recurrence and may recommend disciplinary action.

The monthly district safety meeting minutes and statistical information on the number and type of accidents are briefed for the Division Safety Committee, which meets each month.

Occupational Accidents

All accidents, both industrial and motor vehicle, involving Division of Highways personnel or equipment are coded monthly and annual statistical reports prepared. Accidents are reported according to the American Standards Method of Recording and Measuring Work Injury Experience. Frequency and severity rates are compiled, and used to determine the effectiveness of the program.

The Division of Highways has shown an almost continuous yearly reduction in accidents since the establishment of a formal safety program. In 1941, the accident rate was 49.85. This rate has been reduced to 14.62 in 1960. The reduction in frequency has been accompanied by an increase of employees from 5,500 in 1941 to 15,566 in June of 1961.

The effect of the accident reduction is indicated in compensation insurance costs which have been reduced from 0.58 per $100 of payroll in 1950 to 0.28 per $100 of payroll in 1960.

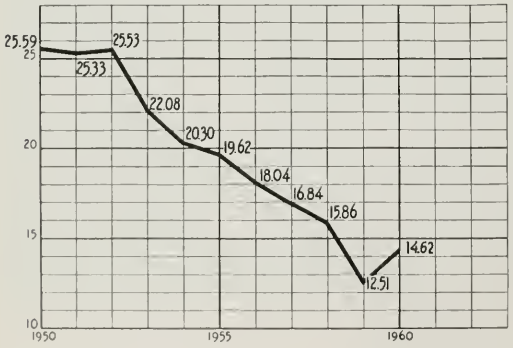
Driver Training

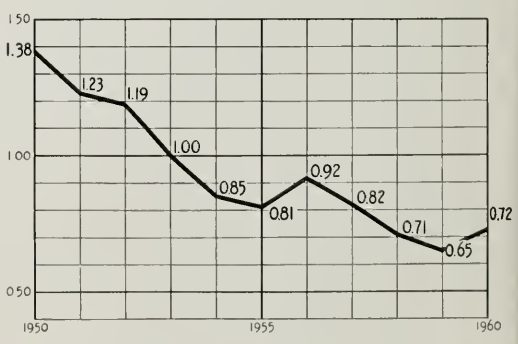
During the year, the Division of Highways generated 31,807,148 miles and had a frequency rate of .72 as determined by the formula,

$$\frac{(\text{number of recordable accidents} \times 100{,}000)}{\text{total mileage}}$$

All employees who drive a state-owned vehicle have now had a course in defensive driving. New employees are given the course and have their previous driving record reviewed. Older employees who have three or more accidents are subject to review of their motor vehicle driving record, additional training, removal of the privilege of driving a state car, or disciplinary action.

The driver training program consisted of a three-hour lecture, a road observation run, and psychological tests to determine visual acuity, depth perception, peripheral vision, color vision, and reaction time. These tests were designed for the employee to determine for himself or be advised of his personal limitations so he could compensate for these limitations in his driving activities. A total of 15,044





were provided this defensive driver training.

Fire Prevention

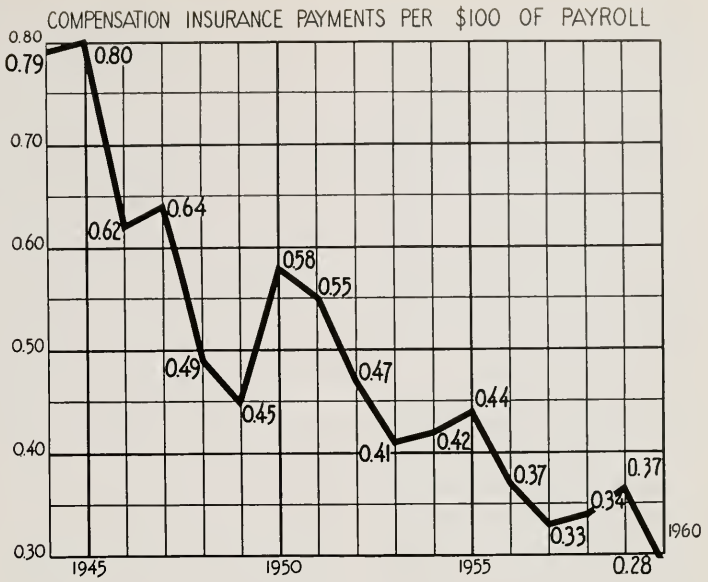
The Safety Section continues to promote meetings throughout the State where fire extinguishers are demonstrated and employees are given an opportunity to practice with them. Fire protection equipment most appropriate to different types of fire are stressed.

Employee Suggestion Program

The Merit Award Program (both employee suggestions and work improvement proposals) within the Division of Highways is handled by the Safety Section.

Work of this activity for the fiscal year 1960-61 is summarized as follows:

Total number of suggestions (including WIP's) processed	960
Total cash awards	160
Total amount of cash awards	$4,150.00
Total number of certificates of commendation awarded	97
Total estimated savings resulting	$41,500.00



AUDIO-VISUAL

The audio-visual section assists headquarters departments and the districts in producing graphic or sound recording aids for personnel training or public information uses.

A large collection of colored slides covering statewide highway scenes and a wide variety of technical engineering and construction operations is kept up to date. Audio-visual equipment is made available for use by headquarters or district personnel in training or public presentations.

The staff of the section has recently prepared slide presentations on "Prestressing Concrete," "Management Development," "Data Processing," and "Slip Form Construction." It has also completed a filmstrip on "Embankment Construction."

PUBLIC INFORMATION

Wide public interest in California's highway program continued throughout the fiscal year. Extensive use was made by the press and other media of both routine and special news releases. Many inquiries by specialist writers were answered and a large number of photographs made available.

Special Events

The Division of Highways joined with other highway departments throughout the nation in observing National Highway Week May 21-27, as proclaimed by President Kennedy and supported in a statement by Governor Brown. Wide use was made of a special statewide news release reporting progress in freeway and other highway construction. The various districts co-operated with news media in presenting the highway picture on the local level.

The division continued State Fair exhibits in 1960 and 1961 after this activity was resumed in 1959. The 1961 exhibit was in the educational area opposite the Hall of Flowers and featured the landscaping of freeways. In the foreground of an exhibit space measuring 36 x 10 feet was a model of a city section of landscaped freeway and on the rear wall enlarged color photographs of existing freeway sections. Ribbons from the photographs keyed the planting to 12 types of shrubs and plantings used, so that the viewer could identify the actual plants with the photographs.

Publications

The bimonthly magazine *California Highways and Public Works* continued as the principal publication of the Department of Public Works and the Division of Highways. While its main distribution is in California to employees of the division and other interested persons, there was a growing demand for it in other states and foreign countries. Numerous articles from the magazine were reprinted, and many photographs were furnished to editors and writers for foreign and domestic publications.

Public information material issued in published form included, in addition to regional material prepared by the various districts:

- —"California Highways-1960", a 12-page illustrated reprint from *California Highways and Public Works* magazine constituting a concise, nontechnical version of the division's annual report.
- —"California's Freeway Planning Team", a leaflet prepared principally for the use of legislators and public service organizations in explaining highway planning procedures.
- —"California Roadsides", a 38-page reprint of four articles on landscaping and functional planting which appeared in *California Highways and Public Works*, plus an exhaustive list of suitable plants.
- —"Freeway Facts", an illustrated booklet containing basic information about freeways and route adoption procedures, widely used at district public meetings (reprinted in 1961).
- —Reprints of articles and district roundups published in *California Highways and Public Works*, used as informational mailing pieces to answer a wide range of inquiries.
- —"Clip Sheet", which provides information for use in employee publications issued by each district and some headquarters departments, as desired by the respective editors.
- —"Report to the Governor", a monthly summary of important developments in the work of the Department of Public Works, intended for the information of department heads in state government and the press.

Route Considerations

News releases on routings considered and acted on by the California Highway Commission totaled 90 during the fiscal year, of which 33 were accompanied by maps specially prepared for newspaper reproduction. Due advance publicity was given five public hearings scheduled by the commission.

Other News Releases and Media Contacts

The continued expansion of the California highway program was reflected in the quantity and scope of news releases issued by the division, with a continued increase in this activity in the various districts. A large number of photographs of highway projects were supplied to newspapers and magazines on request, particularly on major freeway projects.

Information on the highway program was also issued through telephone calls, office interviews, correspondence and appearances by division personnel on radio and television programs, and before local civic organizations and service clubs.

Traffic is now using this recently completed expressway bypass of San Juan Bautista on State Sign Route 156. The new route replaced the former highway (left) through the center of town.



Recently completed section of the Golden State Freeway (US 6-99) in the vicinity of Burbank, which will be part of the future "loop bypass" around the central district of Los Angeles.



• Right-of-way

• *The Right-of-Way Department appraises and acquires property required for state highway purposes; manages such property in the preconstruction period, and arranges for the removal or relocation of improvements and utility facilities to clear the right-of-way. It also handles appraisals, negotiations, and purchases for the Department of Water Resources and the State Public Works Board. There was an average of 517 individuals working in right-of-way classes during the year.*

During 1960-61, the right-of-way department completed 9,293 property transactions involving a total expenditure of $159,719,779.30. Of these transactions, 8,305 involved acquisitions for highway right-of-way, 641 were for utility relocations, and 347 for other uses, such as for other state agencies.

The distribution of the total expenditures is as follows:

Highway right-of-way	$129,847,629.12
Utility relocation to clear highway right-of-way	9,032,728.30
Acquisition other than right-of-way (primarily lands purchased for other state agencies)	8,404,025.36
Overhead (total—including right-of-way activities, land management, right-of-way clearance, fees for title services and administration)	12,435,396.52

Land Management

This phase of the department's operation included the leasing of 7,475 properties during the interim period between acquisition and clearance of rights-of-way and also included the sale of improvements and excess properties.

The fiscal year produced a gross return to the State Highway Fund of $12,622,682, which is an increase of $604,166, or 4.8 percent, over the preceding fiscal year.

Excess Land and Utility Relocation

Excess lands not required for right-of-way purposes are returned to private productivity and tax rolls as soon as possible. During the year, 698 parcels of excess land were sold or exchanged. These excess parcels were acquired to avoid payment of excessive damages or because the remainders were too small or irregularly shaped to be developed economically as individual parcels. The department has combined many small and irregularly shaped parcels and by this process has returned many desirable sites to public use.

Relocation of utility facilities to accommodate proposed highway construction, is the responsibility of the right-of-way department. Relocation costs have increased appreciably in the past 15 years. During the year, 641 state-utility owner transactions for relocation totaled nearly $22,000,000.

Acquisition Policy

Acquisition of properties is based on the undeviating policy that all owners be allowed sufficient time to consider the settlement offer and to make arrangements to relocate with a minimum of hardship. A request for resolution of condemnation is not pre-



Freeway is now being built on U. S. Highway 101 through Ventura. The project includes a new bridge over the Ventura River (top center) at the northwest city limit.



This February photo shows heavy grading on the route of the San Diego Freeway through the Santa Monica Mountains in Los Angeles County. The project requires massive excavations. Bridge in background will carry Sepulveda Boulevard over the future freeway.

sented to the California Highway Commission until it is clear that a reasonable time for deliberation and decision has been afforded the property owner.

Despite pressures of meeting construction schedules, the time allowed for the process of appraisal and negotion must be sufficient to permit determination of fair market value.

Acquisition Methods

The department will not permit "horse trading" in negotiations for the purchase of properties. The department's fair market value one-price policy was established many years ago to protect the interests of the property owners, as well as the State, and especially those owners who may be unfamiliar or inexperienced in real estate transactions and values.

The effectiveness of these policies and methods is evident from the ratio of negotiated settlements to contested court cases. During the fiscal year, of the 8,305 parcels acquired, only 208, or 2.5 percent, were secured through contested eminent domain proceedings.

Personnel

The major problem still confronting the right-of-way department in accomplishing its extensive land acquisition program is the serious shortage of experienced personnel with knowledge and abilities in four major occupational fields—appraising, acquisition, property management, and economic analysis of data pertaining to community development.

During this year, the right-of-way department lost 53 experienced agents, or approximately 10 percent of its total personnel. This percentage loss has been constant for the past five years. Since it takes about three years for even the most qualified new agent to attain the associate or journeyman level, it is apparent that the department is forced to carry an extremely high percentage of new and inexperienced personnel. This group requires constant and intensive training.

During 1960-61, it was necessary to devote more than 15,000 classroom and home study hours to right-of-way instruction. This includes attendance at colleges and universities, as well as instruction by staff members.

Land Economic Studies

The land economic studies section is the basic research branch of the right-of-way department. Its major assignment is to document the effects of freeway construction. This is done for four reasons: to furnish material for public guidance; to improve the accuracy of the appraisal process; to permit the relation of engineering factors to public requirements; and to increase the effectiveness of negotiations.

Continuing projects of the land economic studies section include examinations and tabulations of the effects of right-of-way acquisition and freeway construction upon adjoining parcels and lands; the personal and community effects of the displacement of people and homes from within the right-of-way areas; the effects upon business caused by diversion of traffic to new freeway bypasses; and the effects of freeway construction upon various communities and regions.

During the past year, studies were begun in 15 California towns bypassed by new freeway facilities. Reports on 22 separate freeway projects were received and analyzed in the continuing remainder parcel study which deals with property from which a portion was acquired, leaving a remainder outside the right-of-way limits. Agricultural land research was continued. (Results of remainder parcel studies and agricultural land research were reported during the year in *California Highways and Public Works*, the official journal of the Division of Highways.)

Investigation of what happens to people, homes, and businesses displaced by a freeway was also continued. The first report on this study was issued in 1960. Additional data for further study were obtained this year in Merced and Modesto.

Legal

The Division of Contracts and Rights-of-Way is the legal division for the Department of Public Works and renders a variety of legal services to the department, its Division of Highways and the Highway Commission.

Some idea of the volume of condemnation casework is given by the following tabulation: (The parcel count is based on a count of parcels in condemnation resolutions.)

Suits filed	458
Parcels involved	2,930
Defendants involved	12,222
Suits closed	233
Trials	223
Uncontested judgments	165
Suits pending 6-30-61	684
Parcels pending 6-30-61	3,069

There was a notable increase in suits filed as compared with the previous fiscal year—a 35 percent increase from 298 suits to 458. The total suits closed, 233, represented total awards of $11,811,421.09 and represented 1,050 days in court.

Appellate Cases

During the fiscal year many appellate court briefs were prepared by the division and appeals argued. Decisions have been rendered in *People* v. *Keligian*, 182 Cal. App. (2d) 771 (6 Cal. Rptr. 680); *Armas* v. *City of Oakland*, 183 Cal. App. (2d) 137 (6 Cal. Rptr. 750); *People* v. *Henry*, 193 A.C.A. 526 (14 Cal. Rptr. 456); *People* v. *Symons*, 54 Cal. (2d) 855 (9 Cal. Rptr. 363, 357 P. 2d 451); *People* v. *Murata*, 55 Cal. (2d) 1, (9 Cal. Rptr. 601, 357, P. 2d 833). The cases of *People* v. *Symons* and *People* v. *Murata* were the subject of an article in the September-October 1961 issue of *California Highways and Public Works* magazine.

The case of *People* v. *Henry*, decided by the First District Court of Appeal, is a square holding that the Department of Public Works may undertake a utility facility relocation when the owner refuses, after notice and demand, to do the work. The department may recover the reasonable cost of the relocation when the owner's rights are subordinate to those of the public. The case is significant in two other respects. First, the relocation in question, undertaken by the department's forces, was in a county highway. Second, the court stated that if a utility having a franchise can be compelled to move its pipes at its own expense, "then *a fortiori* one having no franchise (and no prior easement) can be so compelled."

The case of *Armas* v. *City of Oakland* affirmed the judgment of the Superior Court of Alameda County. The appellate court held that the freeway agreement between the California Department of Public Works and the City of Oakland under Streets and Highways Code Section 100.2 was valid. The appellant argued that the agreement involving closing of city streets by the construction of a freeway could only have been made after notice and where procedures, prescribed by other statutes, had been followed. The court, however, ruled that such formalities need not be followed under Streets and Highways Code Section 100.2. The appellant's motion for a hearing by the Supreme Court was denied.

In each of the above appellate decisions the department was successful in the appellate courts. Several other cases are pending before the Supreme Court and the district courts of appeal, either awaiting argument or decision.

Other Litigation

In addition to the condemnation proceedings, the department's attorneys have handled a large number of miscellaneous cases. The following tabulation covers a wide variety of litigation and indicates the immense increase in this phase of the division's work.

At the start of the fiscal year, there were 526 cases pending, another 526 cases were filed during the year, for a total of 1,052 cases being processed.

Contractor's crews are carving a new route for U.S. 395 over Conway Summit in Mono County to replace the present steep and curving highway.



There were 334 cases closed during the year, leaving 636 cases pending on June 30, 1961. Some of these cases involved claims for damage to state highway facilities, such as bridges, signals, guardrails, or damage to state vehicles, or unlawful detainer actions. During the fiscal year collections in these cases by the Legal Division amounted to $165,960.84.

A substantial portion of this amount is due to the collection by the State for damage to the San Mateo-Hayward Bridge caused when the S.S. Pt. Reyes struck the bridge on November 17, 1959.

The case total includes many cases where the department was represented as a defendant, such as inverse condemnation proceedings for damage to property by reason of the state highway operations, suits by contractors for additional compensation on construction contracts, and suits filed because of alleged dangerous and defective condition of state highways, and suits for injunction against the State and its contractors enjoining the construction and building of highways. And still other types of suits, such as stop notice actions. The department has filed interpleader actions in which it assumes a neutral position between the contractor and claimant.

Proceedings Before PUC

The division handles matters before the Public Utilities Commission having to do with both crossings of grade at highways and railroads, and the construction of grade separations. The following table indicates the volume of work handled by the division in this category:

Applications pending 7-1-60	13
New applications filed	34
Total applications before PUC	47
Decisions received	34
Applications pending 6-30-61	8

In addition to formal applications, 10 proceedings under PUC General Order 88 relating to crossings at grade were processed. In all instances the approval of the PUC must be obtained as to engineering detail and, in the event of a failure to reach an agreement with the railroad involved as to apportionment of cost, the applicant seeks such determination by the PUC. A recent enactment by the Legislature has set up a new formula for apportionment of cost except for federal-aid highways. This has substantially reduced the number of contested cases.

Board of Control and Other Claims

Claims against the State by reason of the activities of the department are filed with the State Board of Control. The following tabulation illustrates the volume of work handled by the department's attorneys before the State Board of Control:

	Number of claims	*Amounts of claims*
Pending 7-1-60	81	$3,149,792.58
Filed	193	7,175,284.12
Totals	274	$10,325,076.70
Disposed of	178	5,590,116.61
Pending 6-30-61	96	$4,734,960.09

There was an increase of 65 claims filed over the previous fiscal year which amounted to $3,051,276.10. The principal types of board of control claims as listed above are for negligence, breach of contract and inverse condemnation.

Other claims filed with the department employees and the governor numbered 38, an increase of six over the previous fiscal year.

The primary reason for the increase in the number of claims filed is due in a large part to the recent decision of the California Supreme Court in the case of *Muskopf* v. *Corning Hospital Dist. Assn.*, 55 A.C. 216. This decision greatly expanded the potential liability of the State, particularly for accidents arising out of the dangerous or defective condition of state highways. The 1961 Session of the Legislature enacted Chapter 1404 which, in effect, reinstates the immunity of the State from liability for a period of two years. This legislation still permits the filing of claims against the State but merely postpones the actual litigation. This enactment will necessitate the careful investigation by district personnel of all claims. It is anticipated that because of the *Muskopf* decision the number of claims will increase substantially.

Contractors' claims before the State Highway Engineer's Board of Review for additional compensation have increased notably. These claims have required considerable work, both in the studying and handling of the claims as well as resulting litigation. Directly proportional to the number of board of review hearings is the increased number of lawsuits against the department arising out of construction contract claims. As of June 30, 1961, 12 lawsuits against the State were pending involving damages totaling $2,120,483.52.

House Counsel Work

The "house counsel work" of the division has also shown a decided increase. This work consists largely of legal opinions directed toward preventing litigation rather than engaging in litigation after damage has occurred.

Also, other routine work has increased, such as approval of contracts and leases, reviewing forms and accident reports. This work is directly proportional to the increased volume of the highway program. In addition, there were six contested hearings before the State Personnel Board.

Accounting

Administration of all accounting and internal audit activities of the Division of Highways is under the direction of the Comptroller of the Department of Public Works and his staff.

On June 30, 1961, cash and securities on hand amounted to $144,915,679, with $112,545,590 being invested in United States Government obligations. On the same date, there were outstanding budgetary obligations of $357,903,753, of which $68,017,813 were advance obligations of the 1961-62 fiscal year.

Cash and securities on hand decreased $20,473,993 during the year and budgetary obligations increased $77,866,672, indicating a considerable acceleration in the highway construction program.

Revenue and Expenditures

Revenues budgeted for 1961-62 fiscal year amounted to $597,593,268, of which $216,875,742 remained to be collected on June 30, 1961. Collection of the revenue not received, which consists of $210,139,614 of federal aid and $6,736,127 of contributions from state and local agencies and other sources, will be made as work against which the amount applies is completed or billed. Revenues budgeted for the prior fiscal year amounted to $652,699,954, the decrease in the 1961-62 fiscal year being caused by a smaller apportionment of federal funds.

Expenditures and obligations incurred during the fiscal year ended June 30, 1960 amounted to $676,123,729, as compared to $580,464,870 for the prior fiscal year.

Accounting Pracedures

Several improvements and revisions in accounting procedures were made during the year.

To facilitate accounting and improve project cost records, construction engineering costs have been included in project fund allotments, except on major construction on state highways. The major projects were excluded from the change, to avoid tying up large amounts of money on projects of long duration.

Separate control accounts were established for county highway construction, emergency damage repair on local roads, and work for other agencies to provide readily available information of the volume of such work and to promote improved functional analysis of expenditures.

Control accounts were changed to include separate figures on highway planning costs financed from federal aid funds and other funds. Provision was also made for charging costs of special investigations and studies, not related to highway planning, to administration accounts.

Procedures were instituted to account for amounts retained on contract payments as project charges and liabilities, in order to better show the current status of project expenditures and obligations.

Revisions were made in the accounting procedures for maintaining and operating traffic signals and intersection lighting in co-operation with other agencies, for the distribution of vacation, sick leave and retirement costs to projects, and for record keeping on construction projects.

Electronic Data Processing

As a result of pilot studies in several districts, it was decided to begin using electronic data processing equipment on a statewide basis to analyze costs as to source, activity and object of expenditure in much greater detail.

In connection with this program, accounting machines were purchased and installed in the district offices. These machines are now being used to post the allotment ledgers from the cost distribution documents. The machines also produce a punched tape which is processed at headquarters office to produce punched cards. The cards are used in other machines to obtain a comprehensive and elaborate analysis of costs for management and other purposes.

Procedural and coding manuals were published setting forth the changes in the cost distribution procedure required and prescribing a system of codes to be used in analyzing expenditures.

Training sessions were held to instruct personnel in the use of the manuals and the new machines and to acquaint district accounting officers with the requirements and possibilities of electronic data processing methods.

Concurrent Audit Program

Initial steps have been taken in conjunction with the United States Bureau of Public Roads to establish a "concurrent audit" program. The objective of the program is to improve the accounting system through the development of uniform cost distribution methods and internal review and internal audit procedures so that cost records may be accepted by the bureau without detailed audit and subject only to continuous tests as to compliance with the procedures prescribed. Attainment of the objective will facilitate and expedite the collection of federal aid funds, with a considerable decrease in effort on the part of the division and the bureau, and will result in an over-all betterment in the accounting system.

• 1962-63 Budget

• *Provides Funds for 202 Projects Including 278 Miles of Freeway*

The California Highway Commission has adopted a record $658,370,017 state highway budget for the 1962-63 fiscal year.

The budget contains $527,792,917 for state highway construction purposes, including rights-of-way.

The previous budget, adopted in October, 1960, contained an overall total of $633,460,812 of which $509,078,312 was for construction purposes.

State Director of Public Works Robert B. Bradford, Commission Chairman, said the budget is up from last year as a result of increases in federal highway apportionments and in estimated revenue from state sources.

A total of $286,631,017 in federal funds has been allotted to California for 1962-63, including $228,847,200 for work on Interstate Highways. The corresponding totals for 1961-62 were $273,570,812 and $220,070,812.

Estimated revenue from state sources is up about $12,000,000 due to the State's improved economic outlook and continuing increases in motor vehicle registration and travel.

The budget provides funds for 202 projects including construction of 278 miles of multilane freeway and expressway and 110 miles of two-lane expressway.

Effective Use of Funds

"The commission is satisfied," Bradford said, "that this budget provides for the most effective use of all available funds.

"It will build many urgently needed freeways in our cities and on major through highways, replace some outdated rural and mountain roads with modern highways, and eliminate scores of local traffic bottlenecks and danger points.

"Although it is never possible to finance all of the state's high priority highway work in a given year, we feel the projects in this budget will provide for substantial transportation improvements in every area of the state."

Major sources of state-collected highway revenue expected for 1962-63 include $270,151,000 in gasoline taxes (up about $6,000,000 from last year's estimate); $60,371,000 in motor vehicle fees (up $4,000,000); $23,690,000 from the use (diesel) fuel tax (down $1,000,000); $14,700,000 from transportation taxes on for-hire carriers (up $1,500,000); and interest on investments and deposits $2,700,000 (up $1,700,000).

The budget contains $57,630,100 for functions other than state highway work.

The largest nonstate highway item is $36,300,000 for major city streets, based on five-eighths cent per gallon of the state gasoline tax. Other nonstate highway items are:

Federal aid for county roads on the Federal Aid Secondary System, $9,215,600; state funds to counties for use in matching these federal funds, $4,200,000; state funds to help finance railroad grade separation projects on local streets and roads, $5,000,000; engineering funds to cities, $1,500,000; and state funds to pay part of the cost of urban extensions of FAS county roads, $1,414,500.

County Share

Bradford pointed out that California's 58 counties receive one and three-eighths cents per gallon from the State's six-cents-per-gallon gasoline tax, plus a portion of the motor vehicle fees. These funds are disbursed directly by the State Controller and are not listed in the State Highway Budget.

For the 1962-63 fiscal year, these state-collected funds for county roads will total an estimated $94,000,000.

The $527,792,917 in the budget for highway construction purposes includes:

Major construction and improvement (contracts plus engineering), $375,973,500; rights-of-way, $135,827,317; contingencies (normally available for construction purposes), $8,000,000; resurfacing program, $4,992,100; signs and striping, $2,000,000; and minor improvements, $1,000,000.

Proposed expenditures for state highway purposes other than construction include: maintenance, $44,700,000; buildings and plants, $9,000,000; administration, $11,500,000; statewide highway planning survey, $3,000,000; maintenance of state toll bridges, $3,500,000; and honor camps, $1,100,000.

The 1962-63 budget contains 28 landscaping, functional planting, or tree planting projects for which $4,178,500 is budgeted. Tree planting projects are listed for the first time, as a result of a policy adopted by the Highway Commission last June which calls for such planting at appropriate locations.

1962-63 State Highway Budget Project by Counties

Note 1: Construction contracts may be awarded beginning January, 1962. Right-of-way funds may not be spent until July 1, 1962 (start of the fiscal year).

Note 2: Projects which overlap county lines are listed in both counties.

Note 3: The term "freeway" means a multilane divided highway with full access control, no crossings at grade, no stop lights and no left turn movements. As used here, an "expressway" is a multilane divided highway with most full freeway features except that traffic may cross at grade at some intersections. "Two-lane expressway" is a two-lane highway with some measures of access control, usually planned for future expansion to four lanes divided.

Route	Description	Approx. mileage	Estimated cost
	ALAMEDA COUNTY		
US 50	MacArthur Freeway—East Bay Distribution Structure to 0.3 mile west of Grand Avenue in Oakland; landscape	2.3	$170,000
US 50	MacArthur Freeway—0.3 mile west of Grand Avenue to Park Boulevard in Oakland; landscape	1.2	195,000
US 50	MacArthur Freeway—0.3 mile west of Buell Street to Kuhnle Avenue in Oakland; construct 8-lane freeway	1.1	4,200,000
US 50	MacArthur Freeway—East city limit of Oakland near Durant Avenue to 0.5 mile east of Sybil Avenue in San Leandro; construct 8-lane freeway (this job and previously listed project, together with current work, will complete 12 miles of 8-lane freeway from the East Bay Distribution Structure to Sybil Avenue)	1.9	4,500,000
US 40	North of El Cerrito Overhead in Albany to San Pablo Dam Road; install median barrier (also listed in Contra Costa County)	4.7	115,000
SR 17	Nimitz Freeway—First Avenue Interchange in San Leandro; add two ramps to interchange		400,000
SR 24	Grove-Shafter Freeway—West of Warren Freeway to Caldecott Tunnel (portions); interchange construction	1.5	2,715,000
HR 108	Alden Lane to El Caminito in and near Livermore; realign curves and bumps	0.9	95,000
HR 226	Posey Tube between Alameda and Oakland; entrance revisions, lighting, ventilation equipment and tiling		1,100,000
HR 227	Warren Freeway—Carson Street to MacArthur Freeway near Calaveras Avenue; grading and structure for future freeway	0.6	600,000
Various	Rights of way (including $5,700,000 for Grove-Shafter Freeway in Oakland, $2,500,000 for MacArthur Freeway in Oakland and San Leandro)		9,398,000
FAS 1030 Urban Extension	Redwood Road—Between Heyer Avenue and Castro Valley Boulevard in and near Hayward; construct 4-lane highway (Urban extension of FAS Road—Alameda County's share, $115,000)	0.5	115,000 (State share)
	ALPINE COUNTY		
SR 88-89	0.3 mile east of Woodfords to 2.5 miles east of Picketts; construct 2-lane expressway	3.8	1,070,000
SR 4	Raymond Meadow Creek Bridge south of Markleeville; replace bridge and construct approaches		65,000
Various	Rights of way		50,000
	AMADOR COUNTY		
SR 88	2.5 miles east of Corral Flat to 2.5 miles west of Alpine County line; construct 2-lane expressway	8.7	1,180,000
Various	Rights of way		75,000
	BUTTE COUNTY		
US 99E	Little Chico Creek to East First Avenue in Chico; construct 4-lane freeway (first unit of freeway through Chico)	1.3	1,700,000
US 40 Alt.	West Branch Feather River Bridge north of Oroville; Division of Highways share of the cost of the bridge and approaches (bridge now under construction)		615,000
Various	Rights of way		470,000
	CALAVERAS COUNTY		
SR 49	SR 12 at San Andreas to Mokelumne Hill; grading and bridges for future 2-lane highway (paving to be budgeted in the future)	6.5	1,100,000
Various	Rights of way		180,000
	COLUSA COUNTY		
US 99W & SR 20	On 7th and E Streets in Williams; drainage improvements	0.2	30,000
SR 20	4.5 miles east of Colusa to Drexler Road; construct 2-lane expressway including new Sacramento River Bridge near Meridian (also listed in Sutter County)	5.1	1,980,000
Various	Rights of way		25,000
	CONTRA COSTA COUNTY		
US 40	North of El Cerrito Overhead in Albany to San Pablo Dam Road; install median barrier (also listed in Alameda County)	4.7	115,000
US 40	Barrett Avenue Off-ramp; construct ramp connection from Sierra Avenue ramp to Barrett Avenue		420,000
SR 24	Junction Sign Routes 21 and 24 to 0.2 mile north of Solano Way in Concord; construct 4-lane freeway	2.9	3,150,000
SR 21	1.0 mile south of Danville to Walnut Creek; construct 4-lane freeway	6.8	12,900,000
Various	Rights of way		2,485,000
	DEL NORTE COUNTY		
US 199	Collier Tunnel under construction at Hazelview Summit near the Oregon Border; install tunnel lighting and ventilation equipment		200,000
Various	Rights of way		120,000
	EL DORADO COUNTY		
US 50	West city limit of Placerville to Railroad Crossing; tree planting		80,000
SR 49	0.4 mile south of Hastings Creek to 0.9 mile south of Greenwood Creek north of Coloma; construct 2-lane highway on new alignment including new Greenwood Creek Bridge (connects with current job to the west)	2.0	280,000
Various	Rights of way		275,000
	FRESNO COUNTY		
US 99	Tulare County line to 0.5 mile north of Highland Avenue in Selma; construct 4-lane freeway (completes freeway on US 99 in Fresno County)	6.9	4,490,000
US 99	Dry Creek Canal to north of West Olive Avenue Interchange in and north of Fresno; landscape	1.6	125,000
US 99	North of West Olive Avenue Interchange to the San Joaquin River north of Fresno; functional and tree planting	8.0	75,000

Route	Description	Approx. mileage	Estimated cost
	FRESNO COUNTY—Continued		
SR 33	Zapato Cheno Creek Bridge north of Avenal; replace bridge deck		$26,000
Various	Rights of way		975,000
FAS 815 Urban Extension	Jensen Avenue—Between Lyon Avenue and West Avenue in Sanger; construct 4-lane highway (Urban area extension of Federal Aid Secondary County Road. Sanger's share $39,500)	0.5	39,500 (State share)
FAS 815 Urban Extension	Jensen Avenue—West of Pullman Street to east of Holloway Avenue in Calwa; construct 4-lane divided highway (Urban area extension of FAS County Road. Fresno County's share, $388,000)	0.7	150,000 (State share)
FAS 1211 Urban Extension	Belmont Avenue—Blackstone Avenue to Fisher Avenue in Fresno; construct 4-lane divided highway (Urban extension of FAS County Road. Fresno's share $110,000)	1.1	110,000 (State share)
	GLENN COUNTY		
HR 45	Walker Creek east of Willows to Glenn; reconstruction and widening (completes improvements between Willows and the Sacramento River near Butte City)	8.3	960,000
Various	Rights of way		325,000
	HUMBOLDT COUNTY		
US 101	Redwood Parks Freeway—1.3 miles south of Sylvandale to Maple Hills Road; construct 4-lane freeway (This project, and current and completed construction will provide 4-lane freeway for 22 miles from Sylvandale to Englewood)	5.8	5,600,000
SR 36	2.6 miles to 7.7 miles east of Bridgeville (portions); curve improvement and widening		100,000
HR 46	Miners Creek near Weitchpec; replace bridge with culvert and reconstruct approaches	0.3	180,000
HR 66	Salt River Overflow Bridge near Ferndale; bridge replacement		70,000
Various	Rights of way		1,120,000
	IMPERIAL COUNTY		
US 80	San Diego County line to junction with SR 98; construct 4-lane freeway	9.7	5,000,000
HR 146	Glamis Highway—9.0 miles east of Glamis to the Riverside County line; construct 2-lane expressway	29.5	1,000,000
Various	Rights of way		1,530,000
	INYO COUNTY		
US 395-6	1.4 miles south of Little Lake to 3.6 miles north of Little Lake; construct 4-lane expressway	5.0	787,000
SR 190	Centennial Wash to 1.0 mile west of Darwin Junction (portions); reconstruct and widen	5.4	245,000
Various	Rights of way		10,000
	KERN COUNTY		
US 99	Minkler Spur to 0.3 mile south of Cawelo; convert expressway to 6-lane freeway	8.7	5,650,000
SR 178	Stockton Street to Williams Street in Bakersfield; reconstruction for one-way street couplet on Monterey and Niles Streets	1.4	480,000
SR 178	Williams Street to 0.2 mile east of Morning Drive in and near Bakersfield; widen to 4 lanes	3.8	770,000
SR 178	Mirasol Avenue to 0.2 mile east of Meadow Street; widen to 4 lanes through Buttonwillow	0.4	98,000
US 399	Sunset Western Railroad to Cedar Street in and near Taft; tree planting		3,000
Various	Rights of way (including $3,950,000 for SR 178 freeway in and near Bakersfield)		5,607,000
	KINGS COUNTY		
HR 135	Central Valley Highway—1.0 mile north of Corcoran to Tulare County line; reconstruction and widening	3.3	278,000
Various	Rights of way		943,000
	LAKE COUNTY		
SR 20	Morrison Creek to 0.5 mile west in Lucerne; curve realignment	0.5	105,000
SR 29	Cobb Post Office to 2.4 mile south (portions); realign		265,000
Various	Rights of way		70,000
	LASSEN COUNTY		
US 299	1.6 miles to 0.6 mile west of Kramer Road in Nubieher; construct 2-lane expressway	1.0	130,000
US 395	1.0 mile east of Johnstonville to 0.4 mile east of Baxter Creek; construct 2-lane expressway	4.2	700,000
US 395	0.8 mile south of Modoc County line to 4.0 miles north of Likely (two sections); construct 2-lane expressway (also listed in Modoc County)	5.4	550,000
Various	Rights of way		100,000
	LOS ANGELES COUNTY		
US 101	Ventura Freeway—0.4 mile southeast of Chesehro Road to Lewis Road west of Los Angeles; construct interchange to convert from expressway to 4-lane freeway		530,000
US 101	Ventura Freeway—Lewis Road to 0.6 mile northwest of Kanan Drive west of Los Angeles (portions); construct interchanges to convert from expressway to 4-lane freeway		500,000
US 101	Ventura Freeway—0.1 mile southeast of Los Angeles County line to 0.4 mile west of Triunfo Road. Construct interchange to convert to full freeway (also listed in Ventura County)		420,000
US 6-99 & 66	Golden State Freeway—Darwin Avenue to Los Angeles River. Pasadena Freeway—Golden State Freeway to 0.2 mile east of Cypress Avenue; landscape	2.0	200,000
US 6-99	Golden State Freeway—Burbank Boulevard in Burbank to Lankershim Boulevard in Los Angeles; install median barrier	6.1	130,000
US 99 & SR 126	Golden State Freeway—1.3 miles south of Sign Route 126 (southerly intersection) to 0.2 mile south of Castaic Creek; and on Sign Route 126 Freeway between the Golden State Freeway and 0.8 mile west; construct 8-lane freeway on US 99 and 4-lane freeway on Sign Route 126	4.5	5,500,000
US 60-70-99	San Bernardino Freeway—Holt Avenue to 0.4 mile west of San Dimas Avenue near Pomona; widen from 6 to 8 lanes	2.9	925,000
SR 138	47th Street East, Fort Tejon Road and Pearbloasom Highway—0.4 mile south of Palmdale Boulevard to 0.2 mile southeast of of Avenue T, southeast of Palmdale; widening to provide a 4-lane divided highway	2.9	290,000
SR 27	Topanga Canyon Boulevard—Ventura Freeway to Roscoe Boulevard in Los Angeles; widening and reconstruction to provide 4-lane divided highway	3.4	1,235,000
HR 158	San Diego Freeway—Orange County line to 0.1 mile west of Atlantic Avenue in Long Beach and Signal Hill; construct 8-lane freeway. (This project, other current work, the newly budgeted job which follows, and a new project in Orange County will complete the San Diego Freeway from Westminster to the Golden State Freeway near San Fernando, a distance of 49 miles)	6.0	14,000,000
HR 158	San Diego Freeway—0.4 mile south of Burbank Boulevard to Golden State Freeway near San Fernando; construct 8-lane freeway (grading and some structure work now in progress on this section)	8.9	8,300,000

Route	Description	Approx. mileage	Estimated cost
	LOS ANGELES COUNTY—Continued		
US 6 & SR 11	San Diego Freeway—Carson Street to 190th Street. Harbor Freeway—0.5 mile north of Del Amo Boulevard to 0.1 mile north of 190th Street in Los Angeles; install median barrier	3.8	$58,000
HR 158	San Diego Freeway—Avalon Boulevard to Main Street near Torrance; install truck scales		131,000
HR 158	San Diego Freeway—190th Street to 174th Street in Los Angeles and Torrance; landscape	3.2	260,000
HR 158	San Diego Freeway—Mulholland Drive to Ventura Boulevard; landscape	1.4	50,000
SR 134	Ventura Freeway—Buena Vista Street to the Golden State Freeway and west side of Golden State Freeway from the Ventura Freeway to 0.2 mile west of Colorado Street extension; landscape in Burbank and Los Angeles	3.3	115,000
US 6-99, SR 2	Golden State Freeway—Los Angeles River to Glendale Boulevard; Glendale Freeway—Glendale Boulevard to the Los Angeles River; landscape	4.0	375,000
US 66	Santa Monica Boulevard—Doheny Drive to Orlando Avenue in and near Beverly Hills; reconstruct and widen	1.2	235,000
US 6-SR 11	Harbor Freeway—0.2 mile north of Sepulveda Boulevard to 0.1 mile south of 208th Street; functional and tree planting	2.1	135,000
SR 35	San Gabriel River Freeway—0.2 mile south of Whittier Boulevard to Peck Road near Industry; construct 8-lane freeway	3.3	4,750,000
SR 35	San Gabriel River Freeway—Peck Road to 0.3 mile north of the San Bernardino Freeway; construct 8-lane freeway in and near Industry and Baldwin Park. (This project, and previously listed job, are first major construction projects on the San Gabriel River Freeway)	3.9	6,850,000
SR 26	Olympic Boulevard—Centinela Avenue to Rimpau Boulevard (portions); modify traffic signals at 24 intersections (Cooperative project—Los Angeles City's share, $60,000)		60,000 (State share)
SR 25 & SR 7	Santa Monica Freeway—0.3 mile west of Sawtelle Boulevard to Overland Avenue. San Diego Freeway—0.4 mile south of National Boulevard to 0.2 mile north of Pico Boulevard; construct 8-lane freeway on the Santa Monica Freeway including interchange at San Diego Freeway near Culver City	2.5	7,300,000
SR 25	Santa Monica Freeway—Overland Avenue to La Cienega Boulevard in Los Angeles; construct 8-lane freeway	2.2	6,700,000
SR 25	Santa Monica Freeway—0.1 mile west of La Cienega Boulevard to Fairfax Avenue; construct 8-lane freeway	0.5	3,700,000
SR 25	Santa Monica Freeway—0.1 mile west of Fairfax Avenue to Hoover Street; construct 8-lane freeway. (The preceding four projects, together with current construction, will complete the Santa Monica Freeway from the Santa Ana Freeway to Sawtelle Boulevard, a distance of 13.3 miles)	5.0	10,800,000
SR 26	Santa Monica Freeway—Vermont Avenue to 8th Street; landscape	4.3	140,000
SR 42	Firestone Boulevard—0.1 mile east of Garfield Boulevard to 0.1 mile west of Lakewood Boulevard; widening to 4 lanes. (Cooperative project—Southgate and Downey share $70,000)	2.5	385,000 (State share)
Various	Rights of way (including $7,500,000 for the Foothill Freeway, $5,000,000 for Colorado Freeway, $5,100,000 for San Gabriel River Freeway, $8,000,000 for Pomona Freeway, $6,900,000 for Santa Monica and $7,100,000 for the Artesia Freeway)		52,722,000
	MADERA COUNTY		
US 99	0.2 mile north of San Joaquin River to Road 30 south of Madera; convert expressway to 4-lane freeway	5.5	2,000,000
Various	Rights of way		514,000
	MARIN COUNTY		
US 101	Miller Creek Road to north of Entrada Drive in Novato; construct 5-lane freeway	2.7	3,500,000
US 101 & SR 37	Sign Route 37-US 101 Interchange; construct interchange and frontage roads, and 5-lane freeway. (This project and previously listed job, together with other current construction, will provide continuous freeway on US 101 for 19 miles from the Golden Gate Bridge to Novato)	1.2	4,000,000
SR 1	Stinson Beach to Bolinas Road (portions); drainage improvements and resurfacing		100,000
Various	Rights of way		530,000
	MARIPOSA COUNTY		
SR 49	1.5 miles south of Coulterville to Tuolumne County line; construct 2-lane highway	5.8	850,000
SR 132	4.0 miles west of Coulterville to junction with SR 49 in Coulterville; construct 2-lane highway	4.0	685,000
Various	Rights of way		115,000
	MENDOCINO COUNTY		
US 101	6.0 miles north of Hopland to Norgard Lane south of Ukiah; construct 4-lane freeway	4.8	2,250,000
US 101	Ford Road north of Ukiah to 0.5 mile south of Forsythe Creek; construct 4-lane freeway (structures and some grading now in progress on this section)	5.6	2,400,000
SR 20	James Creek Bridge west of Willits; replace bridge and construct approaches	0.3	200,000
Various	Rights of way		400,000
	MERCED COUNTY		
US 99	1.1 miles south of Merced to 4.5 miles north of Merced; construct 4-lane freeway through Merced (structure work and grading now in progress). With completion of this project, there will be 12.2 miles of continuous full freeway from south of Merced to north of Atwater.	8.3	4,200,000
Various	Rights of way		710,000
	MODOC COUNTY		
US 299	0.4 mile west of Pit River Bridge to 1.0 mile east of Canby; construct 2-lane expressway including new Pit River Bridge	5.8	976,000
US 395	0.8 mile south of Modoc County Line to 4.0 miles north of Likely (two sections); construct 2-lane expressway (also listed in Lassen County)	5.4	550,000
Various	Rights of way		10,000
	MONO COUNTY		
US 395	1.5 miles north of McGee Creek to 1.1 miles south of Mammoth Junction; construct 1.8 miles of 2 and 4-lane expressway with right of way fencing on additional section	5.5	550,000
HR 111	June Lake Loop—0.1 mile southeast to 0.3 mile northwest of Rush Creek; realignment and widening	0.4	75,000
Various	Rights of way		35,000
	MONTEREY COUNTY		
US 101	1.2 miles north of Bradley to 1.7 miles south of San Ardo; construct 4-lane freeway	11.3	4,180,000
US 101	South city limit to North Main Street in Salinas; functional and tree planting	2.9	90,000
US 101	Little Bear Creek Bridge at Santa Rita; replace bridge and construct approaches		50,000
SR 1	San Luis Obispo County line to Rocky Creek north of Big Sur (portions); construct concrete retaining cribs		250,000
SR 1	Hot Springs Creek Bridge south of Big Sur; replace bridge and construct approaches	0.5	450,000
Various	Rights of way		1,135,000

Route	Description	Approx. mileage	Estimated cost
	NAPA COUNTY		
SR 37	Vichy Springs to Sign Route 128 (portions); reconstruction and widening		$160,000
SR 29	0.3 mile south of Imola Avenue to north of Old Sonoma Road in and near Napa; functional planting and tree planting	0.7	60,000
SR 12-29	Imola Avenue to Kelly Road (portions); resurfacing		100,000
SR 29	Dry Creek to California Drive near Yountville; reconstruction, frontage roads, and drainage improvement	2.6	425,000
SR 29	1.6 miles north of California Drive near Yountville to Oakville; reconstruction and widening	2.3	160,000
SR 29	Calistoga to Lake County line (portions); construct passing lanes on Mt. St. Helena		80,000
SR 128	0.9 mile east of Pope Valley Road to the Monticello Dam Highway Relocation east of Rutherford (portions); curve improvement and widening		50,000
Various	Rights of way		780,000
	NEVADA COUNTY		
SR 49	1.6 miles north of South Fork Yuba River to North San Juan (portions); curve improvement and widening		60,000
US 40	2.8 miles west of Cisco to Hampshire Rocks; construct 4-lane freeway (final gap in freeway construction on 120 miles of US 40 between Sacramento and Nevada. Leaves only the paving over Donner Summit for future budgeting) (also listed in Placer County)	6.3	10,400,000
Various	Rights of way		273,600
	ORANGE COUNTY		
SR 55	Newport Freeway—0.3 mile south of Delhi Road to 0.3 mile south of the Santa Ana Freeway in and near Santa Ana and Tustin; construct 4-lane freeway	1.9	2,700,000
US 101 Alt.	Pacific Coast Highway—South city limit of Newport Beach to Superior Avenue-Balboa Boulevard (portions); resurfacing, channelization and traffic signal modifications		100,000
SR 39	Beach Boulevard—Atchison, Topeka and Santa Fe Railroad Underpass to 0.1 mile south of Central Avenue in and near Buena Park and La Habra; widening to provide four lanes divided	4.2	990,000
HR 168-179	San Diego Freeway—0.6 mile east of Bolsa Chica Road to Los Angeles County line. Garden Grove Freeway—0.7 mile east of Bolsa Chica Road to San Diego Freeway; construct 8-lane freeway (connects with newly budgeted project in Los Angeles County)	4.8	9,000,000
US 101	Santa Ana Freeway—0.3 mile north of South Street in Anaheim to 0.2 mile south of the Santa Ana River in Santa Ana; widen from 4 to 6 lanes	4.1	1,260,000
SR 22	Garden Grove Freeway—Garden Grove Boulevard near Knott Avenue in Westminster to 0.2 mile east of Newland Street in Garden Grove; construct 6-lane freeway	1.8	4,000,000
Various	Rights of way (including $2,300,000 for Garden Grove Freeway)		6,667,000
	PLACER COUNTY		
SR 49	East Auburn Underpass in Auburn; widen to four lanes		260,000
US 40	2.8 miles west of Cisco to Hampshire Rocks; construct 4-lane freeway (final gap in freeway construction on 120 miles of US 40 from Sacramento to Nevada. Leaves only the paving over Donner Summit for future budgeting) (also listed in Nevada County)	6.3	10,400,000
HR 91	Lincoln-Auburn Highway—US 99E to 0.3 mile east of Lincoln; reconstruction and widening	0.8	130,000
Various	Rights of way		876,600
	PLUMAS COUNTY		
US 40 Alt	Grizzly Creek Bridge and approaches about 2 miles east of Portola; replace bridge and construct approaches	0.4	130,000
Various	Rights of way		76,000
	RIVERSIDE COUNTY		
US 60	US 395 to Kitching Street near Sunnymead; construct 4-lane freeway	4.8	2,760,000
US 60-70-99	East city limit of Banning to east city limit of Cabazon; construct 6-lane freeway. (Completes continuous freeway and expressway for 90 miles from Los Angeles to east Cabazon)	5.7	6,100,000
SR 74	7.0 miles east of Hemet to Mountain Center (portions); widening and curve improvement		20,000
SR 79	Lamb Canyon Creek northwest of San Jacinto; replace bridge with culvert		26,000
SR 195	Coachella Storm Drain to SR 111 near Mecca; reconstruction and widening	1.6	86,000
Various	Rights of way		2,636,000
	SACRAMENTO COUNTY		
US 99-60	Sacramento Boulevard to U Street in Sacramento; landscaping on South Sacramento Freeway	3.0	462,000
US 50	Natoma Overhead Interchange at the Aerojet plant east of Sacramento; tree planting		30,000
US 40 & US 99W	Sacramento River Bridge near W and X Streets in Sacramento; bridge substructure for future freeway crossing (also listed in Yolo County)		1,260,000
Various	Rights of way (including $1,600,000 for North-South freeway (29th and 30th Streets), $2,000,000 for East-West freeway (W and X Streets) in Sacramento and $1,000,000 for Interstate Beltline freeway north and west of Sacramento)		6,610,000
	SAN BENITO COUNTY		
SR 156	0.5 mile north to 3.4 miles north of Hollister; construct 4-lane expressway	2.9	690,000
Various	Rights of way		226,000
	SAN BERNARDINO COUNTY		
US 66	At Deer Creek about 3.6 miles east of Upland; culvert replacement		86,000
US 66	Los Angeles County line to Haven Avenue in and near Upland; intersection and center strip improvements	6.7	36,000
Old US 70-99	Hunts Lane to Oak Street; resurface old highway through Redlands prior to relinquishment to local jurisdiction. (New freeway under construction)	8.1	60,000
US 70-99	Colton Avenue to Highland Avenue in Redlands; landscape	3.3	400,000
US 91-466	6.0 miles west of Yermo to Field; construct 4-lane freeway	22.6	8,600,000
SR 18-30	3.0 miles west to 1.2 miles east of Big Bear Dam; construct 3.0 miles of 4-lane expressway and resurface 1.1 miles	4.1	1,400,000
SR 18	Central Road to Navajo Road in Apple Valley; construct 4-lane expressway. (Cooperative project with San Bernardino County)	1.4	160,000 (State share)
SR 30	West Fork to East Fork of City Creek northeast of San Bernardino; construct additional 2 lanes to provide 4-lane expressway	1.2	126,000
SR 91	Riverside County line to Warm Creek; functional and tree planting	6.3	20,000
SR 138	Los Angeles County line to US 396-91-66; eliminate humps and dips	16.2	360,000
Various	Rights of way		3,976,000

Route	Description	Approx. mileage	Estimated cost
	SAN DIEGO COUNTY		
US 101	0.1 mile north of south city limit of National City to 0.4 mile north of Division Street in San Diego (portions); construct 8-lane freeway	2.5	$4,600,000
US 101 & US 395	Park Boulevard to 6th Avenue in San Diego; landscape in vicinity of 4-level interchange now under construction in Balboa Park	0.5	400,000
US 101	0.6 mile south of Carmel Valley Road southeast of Del Mar to 0.6 mile south of 4th Street; grading and structurea for future 6-lane freeway (paving to be budgeted in the future)	1.8	1,100,000
US 101	0.6 mile south of 4th Street to Skyline Drive northeast of Solana Beach; grading and structures for future 6-lane freeway (paving to be budgeted in the future)	3.4	2,200,000
US 101	Short Street Overhead in Oceanside; construct interchange		500,000
US 395	Aero Drive to Clairemont Mesa Boulevard; widen frontage road (Cooperative project—San Diego share $321,000)	1.6	50,000 (State share)
US 395	Pomerado Road to north city limit of Escondido; signals and channelization	5.2	185,000
SR 94	Merritt Boulevard to Kenora Drive; widening and reconstruction	1.2	110,000
Various	Rights of way (including $3,900,000 for US 101 freeway in National City and San Diego and $2,700,000 for the section between San Diego and Carlsbad)		12,205,000
FAS 731 Urban Extension	Mission Gorge Road—Between SR 12 at Fairmount Avenue and Simeon Drive in and near San Diego; construct 4-lane divided highway (Urban extension of FAS Road, San Diego County's share, $502,300, City of San Diego, $741,700)	6.0	1,000,000 (State share)
	SAN FRANCISCO COUNTY		
HR 224	Embarcadero Freeway—construct Clay-Washington Street ramps	0.4	1,470,000
HR 224	Embarcadero Freeway—First Street to Steuart Street; landscape	0.4	50,000
HR 253	Southern Freeway Extension—Newcomb Street to Army Street; construct 6-lane freeway (will tie in with a budgeted project to carry easterly extension of Southern Freeway from the James Lick Freeway to Army Street)	0.8	5,580,000
US 101 Byp.	Bayshore Freeway—Butler Road to 3rd Street Overcrossing in South San Francisco and San Francisco (portions); resurfacing (also listed in San Mateo County)		420,000
Various	Rights of way		2,970,000
	SAN JOAQUIN COUNTY		
HR 110	US 50 west of Tracy to about 6 miles west of Vernalis; construct 4-lane freeway (Westside Freeway) bypassing Tracy on the west (new Interstate Highway Route 5W)	11.5	6,080,000
US 99	Miner Avenue to Calaveras River near Stockton; functional and tree planting	3.0	50,000
Various	Rights of way (including $1,500,000 for Westside Freeway in and near Stockton)		2,805,000
	SAN LUIS OBISPO		
US 101	North Pismo Beach Separation to 1.0 mile south of Santa Fe Bridge south of San Luis Obispo; convert expressway to 4-lane freeway	5.0	3,100,000
US 101	1.0 mile south of Santa Fe Bridge to Los Osos Road; convert expressway to 4-lane freeway	2.0	1,270,000
US 101	0.3 mile north of Los Osos Road to Marsh Street in San Luis Obispo; convert expressway to 4-lane freeway (This project, and two listed previously, will provide full freeway on US 101 from north of San Luis Obispo to Arroyo Grande, a distance of 19 miles)	1.9	880,000
US 101	San Luis Obispo Creek to 2.2 miles north of San Luis Obispo (portions); resurface		140,000
US 101	0.4 mile south of Santa Barbara Road to Atascadero; construct interchanges at Santa Barbara Road and at Curbaril Avenue to convert from expressway to 4-lane freeway		830,000
SR 1	Oceano Overhead Bridge south of Pismo Beach; replace bridge and construct approaches on new alignment	0.7	250,000
SR 1	1.5 miles south of Camhria to 0.5 mile south of San Simeon Creek; construct 2-lane expressway bypassing Cambria	4.3	1,250,000
Various	Rights of way		790,000
	SAN MATEO COUNTY		
US 101	El Camino Real—Millwood Drive to Euclid Avenue in Millbrae and San Bruno; widen to six lanes divided (Cooperative project—Millbrae and San Bruno share, $290,000)	1.7	530,000 (State share)
SR 1	1.1 miles south of Sharp Park Road to 0.4 mile north of Manor Drive in Pacifica; construct 4-lane freeway for 2.6 miles with grading and frontage roads for an additional 0.6 mile (first unit of freeway in Pacifica)	3.2	3,850,000
US 101 Byp.	Bayshore Freeway—Butler Road to 3rd Street Overcrossing in South San Francisco and San Francisco (portions); resurface (also listed in San Francisco County)		420,000
US 101 Byp.	Bayshore Freeway—Sierra Point Overhead in South San Francisco to Redwood Creek in Redwood City; install median barrier and signs	17.4	435,000
Various	Rights of way (including $2,000,000 for HR 214 improvement in Redwood City and $3,200,000 for Junipero Serra Freeway in vicinity of Daly City and San Bruno)		6,885,000
	SANTA BARBARA COUNTY		
US 101	South Carpinteria Interchange; interchange construction		350,000
US 101	El Sueno Road to Elwood west of Santa Barbara; install illuminated signs		110,000
HR 2	Orcutt Highway—0.6 mile north of Clark Avenue to 1.5 miles south of Santa Maria; construct additional 2 lanes to provide 4-lane expressway	2.9	350,000
SR 1	Solomon Canyon Creek Bridge south of Guadalupe; replace bridge and construct approaches on new alignment	0.3	80,000
SR 166	Deadman's Gulch to Cuyama Maintenance Station; construct 2-lane expressway	5.6	900,000
SR 154	San Marcos Pass to 7 miles north, northwest of Santa Barbara; construct 2-lane expressway	7.0	5,900,000
SR 164	0.4 mile west of Lompoc Canyon Road to O Street in Lompoc (portions); construct 2-lane expressway from west of Lompoc Canyon Road to Lompoc, and widen to four lanes in the city (Cooperative project—U.S. Navy share, $860,000)	6.8	125,000 (State share)
Various	Rights of way		930,000
	SANTA CLARA COUNTY		
HR 113	US 101 to 0.4 mile north of Southern Pacific Railroad near Bernardo Avenue in Mountain View; construct 2 and 4-lane expressway including an interchange at Dana Street and a railroad grade separation structure	1.5	1,475,000
HR 114	Middlefield Road Overcrossing in Mountain View; construct overcrossing and approaches at route of the future Stevens Creek Freeway		425,000
SR 9	0.2 mile south of Prospect Road in Saratoga to US 101 in Sunnyvale; widen to four lanes (rights of way acquired by local agencies)	5.5	740,000
SR 17, HR 239	Junipero Serra Freeway—Sign Route 17 to west of Doyle Road in and near San Jose; construct 6-lane freeway including an interchange at the junction of the Junipero Serra and Sign Route 17 freeways and widening to 6 lanes on SR 17 between Moorpark Avenue and Forest Avenue. (First southerly unit of the Junipero Serra Freeway)	4.7	4,750,000
SR 17	Forest Avenue to the Bayshore Freeway in San Jose; widen San Jose-Los Gatos Freeway to six lanes and expand Coleman Avenue Interchange	3.4	1,200,000
Various	Rights of way (including $3,900,000 for Junipero Serra Freeway)		5,915,000

Route	Description	Approx. mileage	Estimated cost
	SANTA CRUZ COUNTY		
SR 17	0.3 mile north of Sign Route 1 to 0.3 mile south of Carbonero Creek near Santa Cruz; functional and tree planting	2.9	$110,000
SR 17	0.3 mile south of Glen Canyon Road to 0.4 mile north of Granite Creek Road, north of Santa Cruz; funcitonal and tree planting	2.7	50,000
SR 17	0.6 mile north of Granite Creek Road to the Santa Clara County line; drainage improvements and resurfacing	6.3	500,000
SR 152 & SR 1	Main Street in Watsonville to Rob Roy (portions); resurface		180,000
SR 1	State Park Drive Interchange east of Santa Cruz; construct interchange and frontage roads to convert from expressway to 4-lane freeway	1.5	540,000
SR 1	Park Avenue Interchange in and near Capitola; construct interchange and frontage roads to convert from expressway to 4-lane freeway	1.8	710,000
Various	Rights of way		525,000
	SHASTA COUNTY		
US 99	4.4 miles to 2.3 miles south of O'Brien (portions); grading for fill in Shasta Lake for future 4-lane freeway		600,000
US 99	0.5 mile south to 2.5 miles north of the Tehama County line; construct 4-lane freeway through Cottonwood (connects with current construction to provide continuous freeway from just north of Red Bluff to Anderson, a distance of 16 miles) (also listed in Tehama County)	3.0	3,250,000
Various	Rights of way (including $1,500,000 for US 99 between Anderson and north of Shasta Lake, and $200,000 for SR 44 between Redding and Palo Cedro)		1,880,000
	SIERRA COUNTY		
SR 49	Sierra City to Bassetts; construct 2-lane expressway	4.5	1,300,000
SR 49	Sierraville Creek Bridge and approaches; replace bridge and construct approaches	0.1	45,000
Various	Rights of way		50,000
	SISKIYOU COUNTY		
SR 96	Indian Creek Bridge at Happy Camp; bridge replacement		150,000
HR 82	Etna-Yreka Highway—2.4 miles north of Etna to 0.4 mile south of Kidder Creek; construct 2-lane highway (leaves only one unimproved stretch beteen Yreka and Etna)	3.2	324,000
Various	Rights of way		105,000
	SOLANO COUNTY		
US 40	Near Cordelia Road to west of Travis Boulevard west of Fairfield; functional and tree planting	5.4	75,000
US 40	4.5 miles northeast of Vacaville-Dunnigan Cutoff to 1.3 miles north of Dixon-Rio Vista Highway; construct 6-lane freeway	7.0	2,600,000
SR 48	Napa River Bridge near Vallejo; construct bridge substructure		2,850,000
Various	Rights of way		700,000
	SONOMA COUNTY		
US 101	Russian River to Lytton Forestry Station north of Healdsburg; tree planting	3.9	8,500
US 101	1.0 mile south of Washington School Road to 0.6 mile north of Hiatt Road north of Geyserville; construct 4-lane freeway	3.6	2,400,000
SR 12	Farmers Lane to 0.1 mile east to Brush Creek in and near Santa Rosa; widen existing 2-lane highway to provide 4-lane divided section. (Cooperative project—Santa Rosa share $17,000, Sonoma County Flood Control District, $50,000)	0.8	175,000 (State share)
SR 12	0.4 mile west of Occidental Road to 1.2 miles east of South E Street in and near Santa Rosa; construct 4-lane freeway and expressway for 3 miles with rough grading on an additional 1.1 miles	4.1	5,200,000
Various	Rights of way (including $1,500,000 for US 101 freeway at Santa Rosa)		2,455,000
	STANISLAUS COUNTY		
Various	Rights of way		950,000
	SUTTER COUNTY		
SR 20	4.5 miles east of Colusa to Drexler Road; construct 2-lane expressway including new Sacramento River Bridge near Meridian (also listed in Colusa County)	5.1	1,980,000
Various	Rights of way		100,000
	TEHAMA COUNTY		
US 99	0.5 mile south to 2.5 miles north of the Shasta County line; construct 4-lane freeway through Cottonwood (connects with current construction to provide continuous freeway from just north of Red Bluff to Anderson, a distance of 16 miles) (also listed in Shasta County)	3.0	3,250,000
Various	Rights of way		615,000
	TRINITY COUNTY		
US 299	7.9 miles east to 10.0 miles east of Douglas City; construct 2-lane expressway	1.9	1,350,000
Various	Rights of way		10,000
	TULARE COUNTY		
US 99	Paige Road to 0.5 mile north of Prosperity Avenue in and near Tulare; landscape and tree planting	3.7	200,000
US 99	1.0 mile north of Goshen to Traver; convert expressway to 4-lane freeway	5.9	850,000
US 99	1.3 miles south to Fresno County line; convert expressway to 4-lane freeway. (This project and previously listed job will complete freeway development on US 99 in Tulare County)	1.3	660,000
SR 198	Mooney Boulevard to 0.4 mile east of Road 156 in and near Visalia (portions); structures and frontage roads as the first unit of four-lane freeway construction through Visalia (grading and paving to be included in later project)		2,425,000
SR 190	0.5 mile west of Sign Route 65 near Porterville to 0.3 mile east of Hospital Road; construct 4-lane expressway	3.9	1,700,000
HR 133	Visalia-Woodlake Highway—St. Johns River to Ivanhoe; widening and reconstruction	2.2	200,000
HR 135	Central Valley Highway—Kings County line to 1.0 mile south; reconstruct and widen	1.0	92,000
Various	Rights of way (including $2,000,000 for SR 198 freeway in and near Visalia)		2,368,000
	TUOLUMNE COUNTY		
SR 108	1.0 mile east of Mi-Wuk village to 3.7 miles east of Long Barn; construct 2-lane expressway	7.0	1,500,000
SR 108	Eagle Creek Bridge near Dardanelle; replace bridge and construct approaches		65,000
Various	Rights of way		235,000

Route	Description	Approx. mileage	Estimated cost
	VENTURA COUNTY		
US 101	Ventura Freeway—0.1 mile southeast of Los Angeles County line to 0.4 mile west of Triunfo Road; construct interchange to convert to full freeway (also listed in Los Angeles County)		$420,000
US 101	Ventura Freeway—0.3 mile southeast of Genieve Road to 0.2 mile southeast of Las Posas Road near Camarillo; construct interchange and frontage roads to convert to full freeway		450,000
US 101	Ventura Freeway—0.4 mile southeast of Wood Road to 0.3 mile southeast of Vineyard Avenue near El Rio (portions); construct interchange and frontage roads to convert to full freeway		950,000
US 101	Ventura Freeway—0.3 mile east of Telephone Road to California Street in Ventura; landscape	4.5	240,000
SR 118	Los Angeles Avenue—Moorpark Road to Los Angeles County line (portions); intersection improvements and left turn lanes		100,000
SR 126	0.1 mile west of Wells Road to 0.7 mile east of east city limit of Santa Paula; construct 4-lane freeway (connects with freeway now under construction to west)	8.5	7,000,000
Various	Rights of way		3,000,000
	YOLO COUNTY		
US 40 & 99W	Sacramento River Bridge near W and X Streets in Sacramento; bridge substructure for future freeway crossing (also liated in Sacramento County)		1,250,000
US 99W	0.5 mile north of Russell Boulevard to Mullen Crossing north of Davis; reconstruct and widen	5.6	350,000
Various	Rights of way		350,000
	YUBA COUNTY		
Various	Rights of way		160,000

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Recently widened Sacramento River Bridge on U.S. 99 at Redding.



Landscaping on the Bayshore Freeway south of San Francisco.



Interstate freeway construction on U.S. 40 near Baxter in the Sierra

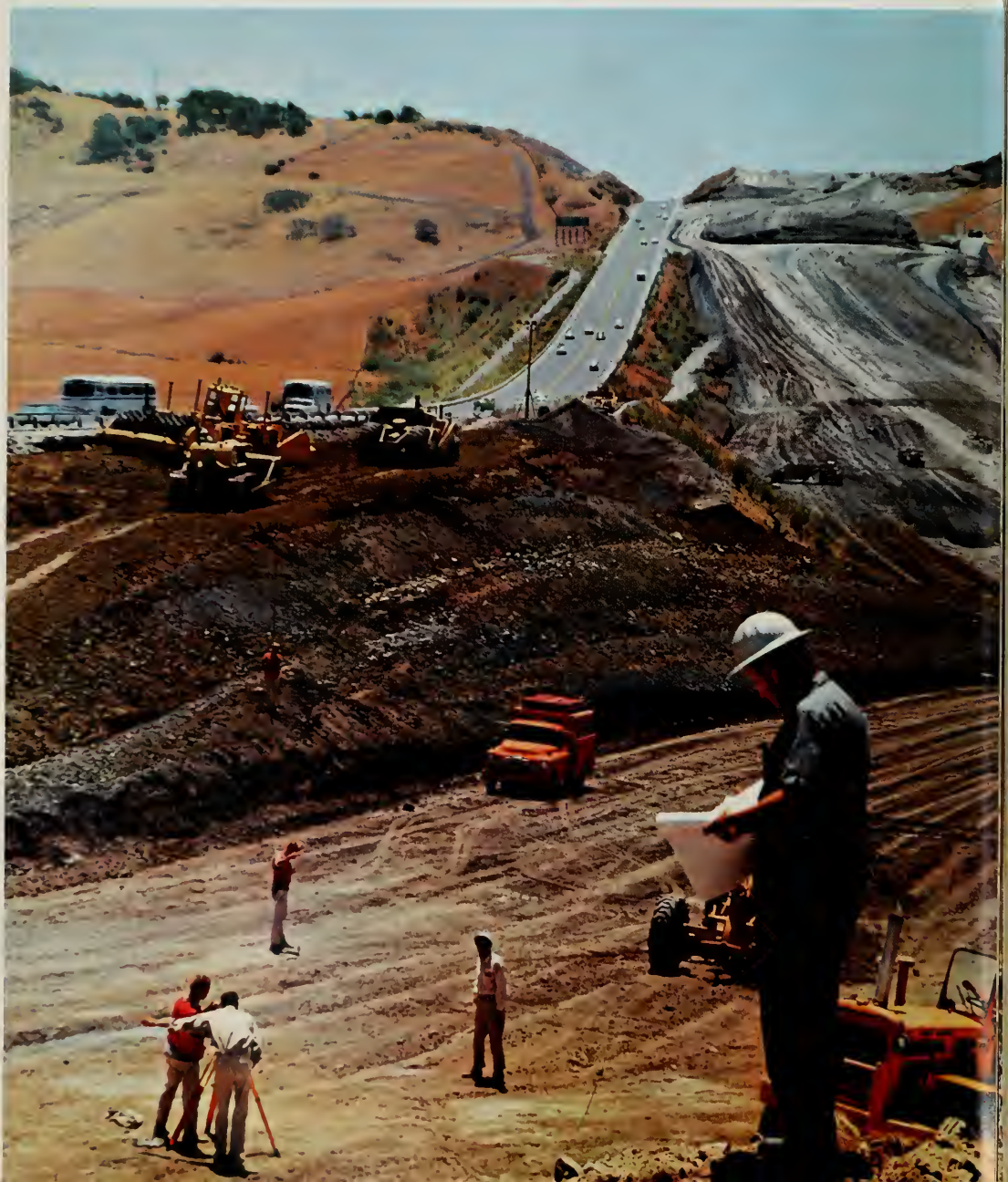
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